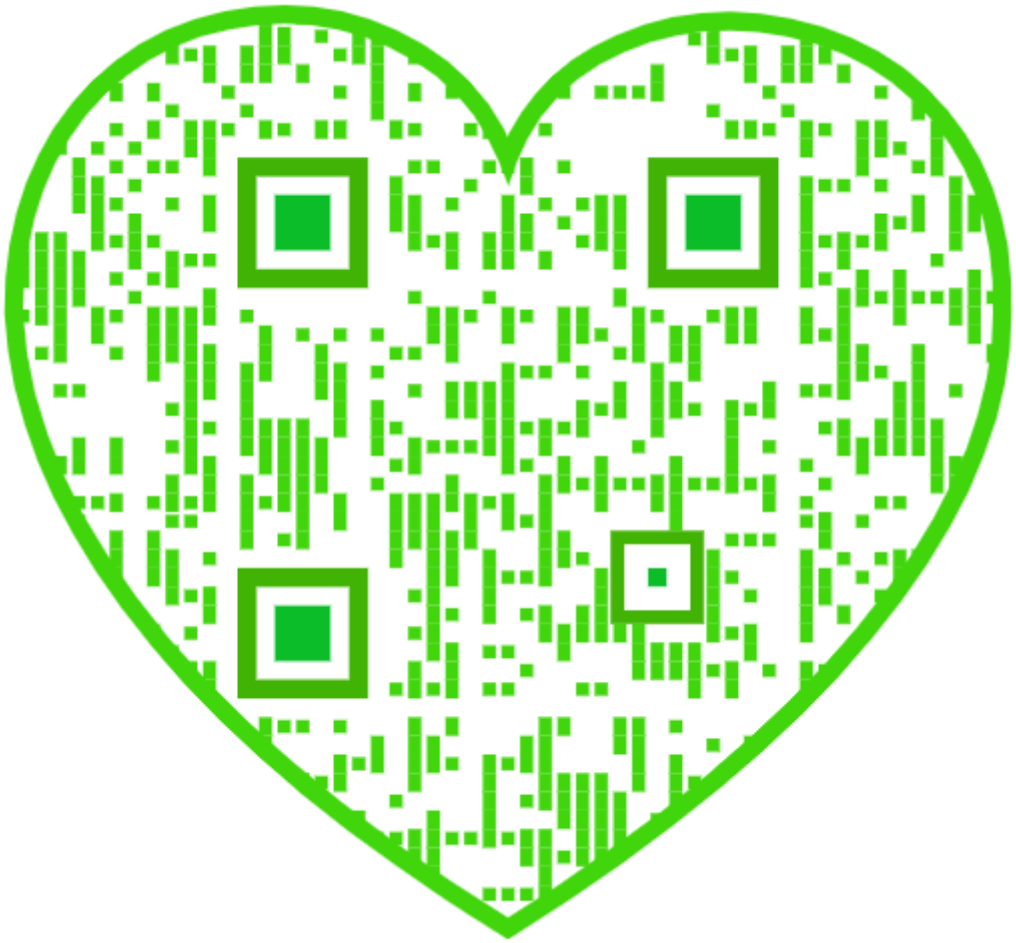

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VEGETABLE ANATOMY AND PHYSIOLOGY,

SUITED FOR BEGINNERS.

Collins' Elementary Science Series

SECOND BOOK OF BOTANY;

BEING

AN INTRODUCTION TO THE STUDY

OF

SYSTEMATIC AND ECONOMIC BOTANY.

SUITED FOR BEGINNERS.

BY

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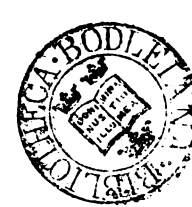

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PREFACE.

In the First Book of Botany, we endeavoured to give an elementary view of the various organs of plants, of the cells and vessels which enter into their composition, and of the functions which they perform. These subjects are included under the names of Botanical Organography and Physiology.

In this Second Book we consider the principles of classification, and the method adopted for the arrangement of plants in classes, orders, genera, and species. A slight reference is made to the plan adopted by Linnæus in his artificial system of classification, which may be called an index to this department of natural science. The principles of the natural system of classification are explained, De Candolle's method is described and illustrated, as being that generally adopted by botanists, in a more or less modified form. Descriptions are given of some of the natural orders which contain plants easily collected in Britain by a beginner.

In Part II. the subject of Economic Botany is brought under notice. Many of the important vegetable products useful in the arts and manufactures, in household economy, and in medicine, are noticed and referred to their classes, natural orders, genera, and species. By this means attention is called to the sources whence many of the articles in common use are derived. Full descriptions of the natural orders in this department are not given, as these are reserved for a more Advanced Book. Meanwhile, the young student is directed in his first steps towards the knowledge of classification.

The system of inserting a series of questions at the end of the different sections has been adopted in this, as well

as in the First Book of Botany. These have been found useful in schools, by fixing the attention of the pupils on the salient points of the subject.

The young student should bear in mind that it is only by a practical examination of plants in the garden and the field that he can acquire a proper knowledge of botany, which is markedly a science of observation.

The full examination of the parts of flowers requires in most cases the aid of a magnifying lens. A simple dissecting microscope, consisting of a single lens, which can be raised or depressed by a screw, and connected with a stand, is very useful to the practical botanist. The compound microscope is not required in ordinary classification, but it must be used if the student wishes to examine minute tissues or the physiological phenomena connected with cells, vessels, movements of fluids, and the formation of the embryo.

In the determination of plants met with during excursions, a field-book is required containing descriptions of genera and species. There are excellent works on the British Flora by Babington, Hooker, and Bentham.

The formation of a Herbarium, or a collection of dried specimens, is useful. After a plant is collected and carefully examined, it may be preserved for future reference by being dried within folds of bibulous paper under pressure. The name, so far as determined, the locality, and the date of collection, being also marked. The mode of making such collections, as well as the apparatus required, and details as to the microscope, are given in my *Botanist's Guide*.

The object of such publications as the present is to encourage the teaching and the study of Natural Science in schools intended for the education of the young, so as to lead them to take an intelligent interest in the works of God.

ROYAL BOTANIC GARDEN, EDINBURGH,
1st May, 1873.

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SECOND BOOK OF BOTANY.

I. SYSTEMATIC BOTANY;

Or, THE CLASSIFICATION OF PLANTS.

CHAPTER I.

GENERAL REMARKS ON THE CLASSIFICATION OF PLANTS.

In examining the Vegetable Kingdom, we observe that the individuals composing it are formed by the Almighty in accordance with a principle of order, as well as a principle of special adaptation. In the *First Book of Botany* we have noticed the structure and arrangements of the various parts of the root, stem, leaves, and flowers of plants, and we have traced, in an elementary manner, their different functions. We now proceed to apply the facts of vegetable anatomy and physiology to the classification of plants, and to consider the plan according to which they are grouped together in classes and families.

We see around us various kinds or sorts of plants, more or less resembling each other—or, in other words, more or less related to each other. In Systematic Botany we endeavour to mark these resemblances, and to determine their relations. It is impossible to give a scientific arrangement of the plants of the globe without a thorough knowledge of structure, and without an extensive acquaintance with the vegetation of all parts of the world. We cannot expect to determine the system on which plants have been grouped, until we are familiar with all the

forms which they present. Hence, in the present state of our knowledge, there must be imperfection in our attempts at systematising. The floras of many regions in Africa, India, China, Australia, and America, are still unknown, and we may therefore conclude that in all systems there will be gaps, to be filled up as our knowledge increases. Sufficient, however, is known to enable us to group plants according to certain evident alliances.

The necessity for arrangement is evident, when we reflect that there are probably 150,000 known species of plants on the earth. In order to make these available for scientific purposes, it is absolutely essential that they should be named and classified. In associating plants in certain groups, we naturally proceed on an idea of resemblance or likeness. While in ordinary language this idea is vague and indefinite, in scientific language it must be strict and rigorous. It is not enough to say that one plant resembles another in its general aspect, we must ascertain the particulars of agreement, and the points in which they differ; we must weigh well the importance of the characters, and must compare organs which are equivalent in value; and thus we shall often find, that plants which to common observers appear alike are in reality totally different. The study of the anatomy of plants gives us a strict and accurate technical language, which must be rigidly adhered to in classification.

Plants, as they occur in nature, are viewed as individuals resembling or differing from each other. Some individuals are so decidedly alike, that we at once give them the same name. Thus a field of wheat is composed of numerous similar individuals which can be separated from each other, but cannot be distinguished by any permanent or marked difference. Although there may be some variation in size and other minor points, still we at once say they are stalks of wheat. Every grain of wheat, when sown, produces a stalk of wheat; these stalks yield grains, which produce individuals like their parents. The shoots or buds given off from the base of wheat by tillering,

also produce stalks of wheat. On such universal and inevitable conceptions as these, our ideas of *Species* are founded.

A Species may be defined as an assemblage of individuals presenting certain constant characters in common, and derived from one original stock. For each species we believe that there has been a parent stock, which has given origin to a succession of similar individuals. They may differ slightly in size, or in colour, and other unimportant respects, but they resemble each other more closely than they resemble any other plants, and their seeds produce similar individuals. Observation and common daily experience demonstrate, in the actual circumstances in which we exist, the permanence of the types which constitute the species of living bodies. There is no evidence whatever of a transmutation of species. The erroneous statements regarding the conversion of oats into rye have proceeded on imperfect observations. The individuals, however, of a species may present certain differences in regard to size, colour, etc., these differences depending on soil, and on varying conditions of heat, light, and moisture. Such differences are not incompatible with the idea of a common origin, and, moreover, there is always a tendency to return to the original type. What are called *Varieties*, therefore, are variations in species, which are not in general of a permanent character, and cannot be kept up in ordinary circumstances by seed. By cultivation, however, such varieties are sometimes perpetuated. This is usually accomplished by means of cuttings or grafts, and in certain instances even by seed. Thus the varieties of the cereal grains and of culinary vegetables have been propagated so as to constitute permanent *Races*.

Plants under cultivation are liable to *sport*, as it is called, and the peculiarities and variations thus produced are sometimes kept up. All the varieties of cabbage, cauliflower, broccoli, savoys, and curled greens, are derived from one stock—*Brassica oleracea*. This plant grows wild on the sea-shore, and when cultivated it undergoes remarkable changes. Thus it forms a heart, as in ordi-

nary cabbage; its flower-stalks become thickened and shortened, as in cauliflower and broccoli; or cellular tissue is largely developed between the vessels of the leaves, so as to give rise to the crisp and curled appearance of greens. This tendency in the plant to produce monstrosities was early noticed by cultivators, and care was taken to propagate those individuals which showed abnormal appearances. The seeds of such were saved, put into good soil, and no plants were allowed to remain except such as presented the required form. In this manner certain races of culinary vegetables have been established. If, however, these cultivated plants are allowed to grow wild and scatter their seed in ordinary soil, they will, in the progress of time, revert to the original type or species. Instances such as these show the remarkable effects of cultivation in perpetuating varieties by seed. In regard to the cereal grains—wheat, barley, oats, etc.—they have been so long cultivated that we are at a loss to know the original types or species. We have been forced, in the meantime, to call them species, although they are probably mere cultivated varieties of unknown species, perpetuated as races.

It is of great importance to distinguish between mere varieties and true species, and to determine the limits of variation in different species. By not attending to this, many mere varieties have for the time been described as species, and thus great confusion and incorrectness have arisen both in descriptions and in arrangements. Another source of fallacy arises from hybrids being occasionally reckoned as true species.

Certain species not identical in origin have common features of resemblance, and are associated together under what is called a *Genus*. A genus, then, is an assemblage of nearly-related species, agreeing with one another, in general structure and appearance, more closely than they accord with other species. Thus, the Scotch rose, the Dog rose, the China rose, and the Sweet-briar, are all different species included in one genus, Rosa, which is well characterised by its fruit, known as the hep of the rose. It may

happen that a single species may be reckoned as forming a genus, when the peculiarities are as marked as those constituting other genera. Thus, if there was only one species of oak, it would be sufficient to constitute a genus, as much so as at present when it includes about 200 species. It is distinguished by its acorn from other allied genera, such as the beech, the hazel, and the chestnut. The species in a genus present one general plan, and may be said to be formed after the same pattern. Some species of a genus, having special points of resemblance, may be grouped together in a *Sub-genus*.

On looking at genera, it will be seen that some of them, such as oaks, hazels, beeches, and chestnuts, have a strong resemblance or family likeness, and that they differ remarkably from such genera as firs and pines, maples and ashes. Certain genera may in this way be grouped so as to form *Orders* or *Families*. While genera are groups of allied species, orders are groups of allied genera, or, in reality, more comprehensive genera. Thus, firs, pines, and larches belong to different genera, but all agree in being cone-bearing, and are grouped under Coniferæ. The rose, the raspberry, the bramble, the strawberry, the cinquefoil, the cherry, and the plum, all agree in their general form and structure, and are united under Rosaceæ. Certain genera have more points in common than others, and are grouped together under subdivisions of orders called *Sub-orders*. Thus, the plum and the cherry have a drupe as their fruit, and are more nearly allied to each other than they are to the apple; again, the strawberry, raspberry, and bramble, are more allied to each other than to the cherry or apple. We have thus Sub-orders of Rosaceæ—namely, Amygdaleæ, including the plum, peach, cherry, and almond; Pomeæ, including the apple, pear, medlar, and quince; Potentilleæ, including the strawberry, cinquefoil, and raspberry; and Roseæ, comprehending the roses.

Certain orders, agreeing in evident and important general characters, are united together so as to form

Classes; and subdivisions of classes are made in the same way as in the case of orders. There are thus *Sub-classes* associating certain orders included in one class.

The usual divisions are thus Classes, Orders, Genera, and Species. These occur in all systems of classification. A more minute subdivision may be made as follows:—

I. Classes.
  a. Sub-classes.
II. Orders or Families.
  a. Sub-orders.
  b. Tribes.
  c. Sub-tribes.
III. Genera.
  a. Sub-genera.
IV. Species.
  a. Varieties.
  (See Chapter II.)

An enumeration of the marks by which one Class, Order, Genus, or Species, is distinguished from another is called its Character. In giving the characters of any division, we notice merely those which are necessary to distinguish it from others. This is called the *Essential Character.* A plant may also be described completely, beginning at the root, and proceeding to the stem, branches, leaves, flowers, fruit, seed, and embryo. This is not essential, however, for the purpose of classification, and would be quite superfluous in that point of view. In the character of the classes the important points of structure on which they are constituted are given. In the character of orders (the ordinal character) we give the general structure of the included plants, especially of their flowers and fruit. In the generic character we notice the modification of the ordinal character in a given genus—the character being taken from the parts of the flower and fruit, as in the order. In the specific character are included certain less important modifications of form, whether in the stem, leaves, or flowers, which serve to distinguish allied species.

The names of the Classes are variously derived, according to the views of the authors in regard to classification. They express some points of structure or development which are of marked importance or permanence. The Orders are named from some characteristic genus

included in them, except in artificial methods, where some organ is taken as the means of distinction. Genera are derived either from the Latin name of one of the species, from the structure or qualities of the included species, or from the name of some botanist, etc. Thus, Prunus is a genus including the plum, the sloe, etc.; Rosa, the rose; Papaver, the poppy; Hookeria is a genus named after Hooker; Lithospermum, from two Greek words signifying a stone and seed, is given to a genus, the species of which have hard stony achenes.

In giving the name of a plant, we mention its genus and species. Thus the common Dog-rose is called *Rosa canina*, the first being the generic name, the second the specific. Specific names may indicate the country in which a plant is found, the locality in which it grows, the form of its roots, stem, or leaves, the colour of its flowers, the name of its discoverer or describer, etc. To the genus and species are added certain letters indicating the botanist who founded them. Thus *Valeriana, L.* is the genus Valerian, as constituted by Linnæus; and *Valeriana officinalis, L.* is the officinal Valerian as described by Linnæus.

QUESTIONS.

1. What idea guides us in the grouping of plants?
2. What is meant by a species? Give an example.
3. What is meant by a variety? Give an example.
4. What is meant by races of plants? Give an example.
5. What is meant by a genus? Give an example.
6. What is meant by an order? Give an example.
7. What is meant by a sub-order? Give an example.
8. What is meant by a class.
9. What is meant by a sub-class?
10. What is the origin of the cultivated cabbage, cauliflower, and greens.
11. How is cauliflower produced? What is the part of the plant used for food?
12. What is meant by the essential character of a species or genus?
13. What is meant by the letter or letters placed after a genus or species?
14. Give an instance of a generic name.
15. Give an instance of a specific name

CHAPTER II.

SYSTEMS OF CLASSIFICATION.

THERE are two systems pursued in the arrangement of plants; one is called the Artificial method, and the other the Natural method. The higher divisions of classes and orders in these systems are founded on entirely different principles, while the genera and species, or the minor divisions, are the same in both. The genera and species are very differently arranged in the two systems. In artificial methods one or two organs are selected in an arbitrary manner, and they are taken as the means of forming classes and orders; while in the natural method plants are grouped according to their alliance in *all* their important characters. Plants belonging to the same class and order in the former system may have nothing in common except the number of the stamens and pistils, or the form of their flowers, or some other arbitrarily-selected character; while in the latter, plants in the same class and order are related by true affinity, and correspond in all the essential points of their structure. When a student knows the artificial class and order to which a plant is to be referred, he does not thereby become acquainted with its structure and properties; plants diametrically opposed in these respects may be associated together. When he determines, on the other hand, the place of a plant in the natural system, he necessarily acquires a knowledge of its structural relations and affinities. Hence a knowledge of the latter system must be the aim of the botanical student.

Artificial System of Classification.

Attempts at an artificial methodical arrangement of plants were made by Cæsalpinus, Morison, Rivinus, and Tournefort, but the system generally adopted was that of Linnæus, founded on the essential organs of reproduction in plants. It is called an artificial method, because it takes into account only a few marked characters in plants, and does not propose to unite them by natural affinities. It is an index to a department of the book of nature, and it does not aspire to any higher character. It will not of itself give the student any view of the true relations of plants as regards structure and properties.

In the artificial system of Linnæus, plants are divided into Flowering and Flowerless—the latter being included in the twenty-fourth class, under the name of Cryptogamia, and the former, or Phanerogamia, being divided into twenty-three classes, the characters of which are founded on the number, the insertion or position, the relative length, and the connection of the stamens. Among flowerless plants the orders are similar to those of the natural system, while in flowering plants they are determined by the number of the styles, the character of the fruit, the number and connection of the stamens in the classes where these characters are not already taken into consideration, and on the perfect or the incomplete nature of the flowers as regards stamens and pistils.

As the Linnean system is not much used now-a-days in practical botany, it is not thought necessary to give a full account of it. Those who wish to study it may consult my *Elements of Botany*, pages 195-201.

Natural System of Classification.

In arranging plants according to the natural system, the object is to bring together those which are allied in all essential points of structure. It is called natural,

because it professes to follow the system of Nature, and thus takes into account the true affinities of plants on a comparison of all their organs. One of the first natural methods of classification was that proposed by Ray, about 1682. He separated flowering from flowerless plants, and divided the former into Dicotyledons and Monocotyledons. His orders were founded on correct views of the affinities of plants, and he far outstripped his contemporaries in his enlightened views of arrangement. He may be said to have laid the foundation of that system which has been elucidated by the labours of Jussieu, De Candolle, Brown, Lindley, Endlicher, and others.

In arranging plants according to a natural method, we require to have a thorough knowledge of structural and morphological botany, and hence we find that the advances made in the latter departments have materially aided the efforts of systematic botanists. We may regard plants in various points of view, either with reference to their elementary tissues, their nutritive or their reproductive organs. The first two are the most important, as being essential for the life of individuals, while the latter are concerned in the propagation of the species. These sets of organs bear a certain relation to each other, and we find that plants may be associated by a correspondence in all of them. In comparing the characters of plants, we must take care that we contrast organs belonging to the same class of functions, and the value of the characters must depend upon the importance of the functions performed by the organs.

Cellular tissue is reckoned of the highest value, as being of universal occurrence, and as carrying on, in many instances, all the functions of plants. In considering the elementary tissues alone, we divide all plants into Cellular and Vascular—the former including the lower tribes of flowerless plants, such as lichens, seaweeds, and mushrooms, the latter including the higher flowerless plants with scalariform vessels, and all the flowering plants. In the nutritive and reproductive organs there is nothing

which can be considered of the same value as cellular tissue. In the nutritive organs the embryo occupies the highest place, and by examining it we divide plants into Acotyledonous, having no cotyledons, but occasionally producing a cellular expansion (prothallus); Monocotyledonous, with one cotyledon; and Dicotyledonous, with two cotyledons. Proceeding to the secondary organs in the nutritive class, we find the stem is Cellular or Thallogenous, Acrogenous, Endogenous, and Exogenous. The thallus is veinless, the fronds of Acrogens have often a forked venation, the leaves of Endogens are parallel-veined, and those of Exogens reticulated. In the reproductive system the stamens and pistils occupy the highest place, as being the essential organs of flowering plants (Phanerogamia), while peculiar cells (antheridia and archegonia) have the same value in flowerless plants (Cryptogamia). Succeeding these organs in value comes the fruit, which is either a theca with spores, or a pericarp with seed. The floral envelopes are the next in the series; they are absent in Cryptogamous plants, and present in Phanerogamous; their arrangement is ternary in Monocotyledons, quinary and binary or quaternary in Dicotyledons.

It is impossible to represent the affinities of plants in a linear series. Different groups touch each other at several different points, and must be considered as alliances connected with certain great centres. We find also that it is by no means easy to fix the limits of groups. There are constantly aberrant orders, genera, and species, which form links between the groups, and occupy a sort of intermediate position. Hence exact and rigid definitions cannot be carried out.

Having examined the general principles upon which the natural system is founded, we shall now give a sketch of the natural system of De Candolle, which is that usually adopted at the present day:—

CLASS I.—DICOTYLEDONES (EXOGENÆ) in which spiral vessels are present; the stem is exogenous; stomata are

present, the venation of the leaves is reticulated; the flowers have stamens and pistils, and the symmetry is quinary and binary (or quaternary); the ovules are either in an ovary or naked; and the embryo is dicotyledonous. In this class there are included four Sub-classes:

Sub-class I.—THALAMIFLORÆ.—Flowers usually with two envelopes (calyx and corolla), petals separate, inserted on the end of peduncle (thalamus), and stamens hypogynous. Fig. 1.

Examples.—Crowfoots, poppies, crucifers, violets, chickweeds, mallows, and geraniums.

Sub-class II. — CALYCIFLORÆ. — Flowers usually with calyx and corolla, petals either separate or united, stamens either perigynous or epigynous. Figs. 2, 3.

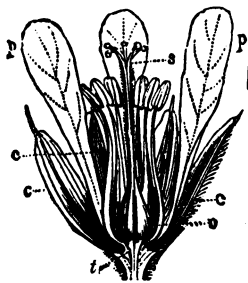


Fig. 1.

Fig. 2.

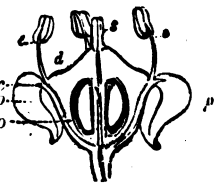


Fig. 3.

The sub-class has two sections—

1. *Polypetalæ*, in which the petals are separate, and either perigynous or epigynous. Fig. 4.

   Examples.—Pea-tribe, rose-tribe, willow-herbs, saxifrages, umbelliferous plants.

2. *Gamopetalæ* (*Monopetalæ*), in which the petals are

Fig. 1. Section of a flower of Geranium robertianum. *cc*, Calyx. *pp*, Petals. *e*, Stamens. Pistil composed of ovary, *o*, and style and stigmata, *s*. *t*, Thalamus or receptacle. The petals and stamens are placed under the ovary, and are therefore hypogynous (Thalamifloræ).

Fig. 2. Section of the flower of the Almond-tree. The letters indicate the same parts as in fig. 1. The petals and stamens are perigynous. The pistil is free (Calycifloræ perigynæ).

Fig. 3. Section of the flower of Aralia spinosa. Letters as in last figure. *d*, Epigynous disk. The petals and stamens are epigynous (Calycifloræ epigynæ).

united and epigynous. Some authors put the plants in this section in the sub-class corolliflorœ on account

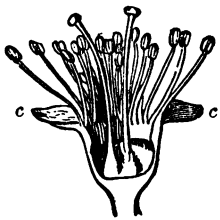


Fig. 4.

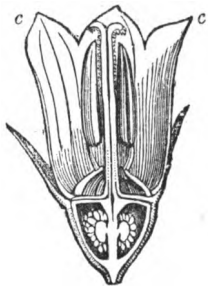


Fig. 5.

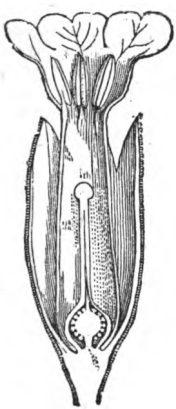


Fig. 6.

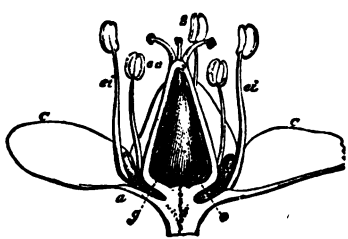


Fig. 7.

Fig. 4.—Flower of Cherry, one of the Rosaceæ, showing a Calycifloral Dicotyledon, with a polypetalous corolla, *c c*.

Fig. 5.—Flower of Campanula, showing a Calycifloral Dicotyledon, with a gamopetalous corolla, *c c*.

Fig. 6.—Flower of Primrose, showing a Corollifloral Dicotyledon, with the stamens united to the corolla, which is hypogynous.

Fig. 7. Vertical section of flower of Buckwheat, with a single floral envelope (perianth) *c c*, stamens *e e* and *e i*. *a*, Gland. *o*, Ovary. *g*, Ovule. *s*, Styles and stigmas. (Monochlamydeæ).

of the union of the petals. In the latter, however, as given by De Candolle, the corolla is hypogynous. Fig. 5.

Examples.—Madderworts, teazels, valerians, composite plants, harebells.

Sub-class III.—COROLLIFLORÆ.—Flowers dichlamydeous (that is, with calyx and corolla), petals united, corolla hypogynous. Fig. 6.

Examples.—Heaths, borage-tribe, potato-tribe, figworts, labiate plants, primroses.

Sub-class IV.—MONOCHLAMYDEÆ (APETALÆ, no corolla), flowers either with a calyx only or none. Figs. 7, 8, In this sub-class there are two sections—

1. *Angiospermæ*, in which the ovules are contained in a pericarp, and are fertilised by the action of the pollen on the stigma.

   Examples. — Dock-tribe, laurels, spurge-laurels catkin-bearing trees.

2. *Gymnospermæ*, in which the ovules are not contained in a true pericarp, and are fertilised by the direct action of the pollen without the intervention of a stigma, and the embryo has often divided cotyledons. Fig. 9. *Examples.*—Cone-bearing trees and cycads.

Fig. 8.

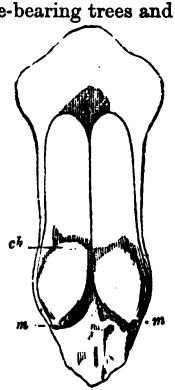


Fig. 9.

Fig. 8. Flower of Euphorbia without a true perianth. It is attached to a bract *b*, and is achlamydeous. *p*, Pedicel. *f*, Filament articulated to the pedicel. *a*, Anther.

Fig. 9.—Scale of a mature cone of Scotch Fir, with two winged seeds at the base, the opening *m*, and the chalaza *ch*.

CLASS II.—MONOCOTYLEDONES (ENDOGENÆ), in which spiral vessels are present; the stem is endogenous; stomata occur; the venation is usually parallel, sometimes slightly reticulated; the flowers have stamens and pistils, and the symmetry is ternary; the ovules are contained in an ovary; the embryo is monocotyledonous. Under this class are included two sub-classes:

Sub-class I.—PETALOIDEÆ, in which the leaves are parallel-veined; the flowers usually consist either of a coloured perianth or of whorled scales. This sub-class is divided into—

1. *Epigynæ*, in which the floral envelopes (perianth) are above the ovary, which thus becomes inferior, and each flower has usually stamens and pistil. Fig. 10.

Examples.—Orchids, bananas, iris, amaryllis, snowdrop, and snow-flake.

Fig. 10.

Fig. 11.

Fig. 10.—Monocotyledon (*Leucojum*), with the ovary inferior, and the floral envelopes and stamens above the ovary (epigynous).

Fig. 11.—Flower of a Monocotyledon, the white lily (*Lilium album*)—floral envelopes below the ovary (hypogynous).

2. *Hypogynæ*, in which the floral envelope (perianth) is below the ovary, which is thus superior, and each flower has usually stamens and pistil. Fig. 11.

Examples.—Lily, meadow-saffron, rushes, palms.

3. *Incompletæ*, flowers incomplete, often staminate and pistillate, with no proper perianth, or with a few verticillate scales. Fig. 12.

Examples.—Arums and screw-pines.

Sub-class II.—GLUMIFERÆ, flowers glumaceous, consisting of imbricated bracts (called glumes), venation parallel. Fig. 13.

Examples.—Sedges and grasses.

Fig. 12.

Fig. 13.

Fig. 12.—One of the incomplete Monocotyledons. A species of Arum, in which the staminate and pistillate flowers are separate, and are each surrounded by minute scales; *a*, pistillate flowers; *b*, staminate flowers; *c*, abortive flowers; *d*, extremity of the spadix.

Fig. 13. — Glumiferous Monocotyledon (Wheat, *Triticum*) consisting of numerous flowers *b*, formed by imbricated bracts called glumelles or pales, and all covered by 2 bracts *a a* called glumes; *s s*, stamens.

CLASS III.—ACOTYLEDONES (ACROGENÆ) in which the plants are either entirely cellular, or consist partly of scalariform vessels; the stem, when woody, is acrogenous; stomata occur in the higher orders; the leaves are either veinless or have a forked venation; no flowers are present; the reproductive organs consist of antheridia and archegonia; spores or cellular embryos are produced, which have no cotyledons. Under this class there are two divisions:—

Sub-class I.—ACROGENÆ (CORMOGENÆ), with a distinct stem, bearing leaves and branches. Fig. 14.

Examples.—Ferns, club-mosses, horsetails, and mosses.

Sub-class II.—THALLOGENÆ (CELLULARES), having no distinct stem or leaves, but forming a cellular expansion of various kinds called a Thallus, which bears the organs of reproduction. Fig. 15.

Examples.—Lichens, seaweeds, and fungi.

Fig. 14.

Fig. 15.

Fig. 14.—An Acrogenous Acotyledon (Royal Fern, *Osmunda regalis*), with an axis and leaves. The upper part of the frond, *f*, bears the fructification, *s*, in the form of sporangia and spores.

Fig. 15.—Thallogenous Cryptogam (Lichen called *Parmelia*), composed of cells, and having rounded spots of fructification containing minute germs.

QUESTIONS.

1. What is meant by an artificial system of classification?
2. What is meant by a natural system of classification?
3. Compare these two systems.
4. On what characters are the Linnæan classes founded?
5. On what characters are the Linnæan orders founded?
6. What is meant by the natural system of classification? Explain its principles.
7. Give a natural division of plants founded on their tissues.
8. Give a natural division of plants founded on the embryo.
9. Give a natural division of plants founded on the stem.
10. Give a natural division of plants founded on the venation of their leaves.
11. Give a natural division of plants founded on their organs of reproduction.
12. Divide flowering plants according to the number of parts in each floral series.
13. Mention the three great classes of the natural system.
14. Give the characters of each of these classes.
15. Give an example of each of these classes.
16. What are the sub-classes of dicotyledonous plants?
17. Define each of these sub-classes.
18. What are the sections of calycifloral plants? Define them.
19. Give the sections of monochlamydeous plants. Define them.
20. Give the sub-classes of monocotyledonous plants.
21. Define these sub-classes.
22. What are the sections of the petaloid monocotyledons? Give their characters.
23. What are the sub-classes of acotyledonous plants?
24. Give the characters of these sub-classes.

When farther advanced, the pupil should be asked to give examples of each of the classes and sub-classes.

CHAPTER III.

CHARACTERS OF THE CLASSES, SUB-CLASSES, AND OF SOME OF THE ORDERS OF THE NATURAL SYSTEM.

In this chapter it is proposed to give the characters of the classes and sub-classes of the vegetable kingdom according to the natural system, and to illustrate them by a few of the more important orders represented in the British flora. By this means the pupil will acquire the method which must be followed in referring plants to their places. The Linnæan system may be used as an index or key to the natural method; this plan is adopted in Babington's *Manual of British Plants*, and in Hooker and Arnott's *British Flora*. In Bentham's *Handbook of British Botany*, and in Hooker's *Student's Flora of the British Islands*, the natural system of arrangement alone is used. Such books as these are necessary in determining the names of plants met with in the fields. In the present work we shall only explain the principles of classification, and give examples of the method to be pursued in ascertaining the names of genera and species. Those who desire to enter into the subject more fully, I would refer to my *Manual of Botany* or my *Outlines of Botany*.

DIVISION A.

Plants with Stamens and Pistils, fertilised by means of Pollen.—Phanerogamous (Flowering) Plants.

CLASS I.—DICOTYLEDONES.

This is the largest class in the vegetable kingdom. The

plants included in it have a cellular and vascular system, the latter consisting partly of elastic spiral vessels. The stem is more or less conical, and exhibits wood and true bark. The vascular bundles are indefinite. The wood is exogenous, *i.e.*, increases by additions at the periphery, the oldest and hardest part being internal; it is arranged in concentric circles. Pith exists in the centre, and from it diverge medullary rays. The bark is separable, and increases by additions on the inner surface. Between the bark and wood there is a cellular layer called the cambium circle. The epidermis is furnished with stomata. The leaves are reticulated, and usually articulated to the stem. The flowers are formed upon a binary or quinary type, and have stamens and pistils. The ovules are either enclosed in an ovary, and fertilised by the application of the pollen to the stigma, or they are naked and fertilised by the direct action of the pollen. The embryo has two or more opposite cotyledons.

Sub-class I.—Thalamifloræ.

Calyx and corolla present; petals distinct, inserted into the receptacle (thalamus); stamens hypogynous. The name Thalamifloræ is derived from the circumstance that the different whorls of the flower (calyx, corolla, stamens, and pistil) are inserted separately on the part called the thalamus, which is situated at the upper end of the flowerstalk (fig. 1).

Various methods may be followed in the arrangement of the orders under the sub-classes. We commence with the Ranunculus order, because in it all the parts of the flower—sepals, petals, stamens, and carpels—are distinct and separate. It would be impossible, in the narrow limits of an elementary work, to give descriptions of all the orders of plants. We shall take some of the common British plants, and by means of them point out the characters of a few of the more important natural orders under which they have been placed.

Order RANUNCULACEÆ, the Crowfoot Family. Sepals 3–6, frequently 5, deciduous (fig. 16, *c*). Petals 5–15 (fig. 16, *pe*), rarely abortive, sometimes anomalous in form, occasionally with scales at the base. Stamens usually indefinite, hypogynous (fig. 16, *e*); anthers (adnate) firmly adhering to their stalk (figs. 18, 19);

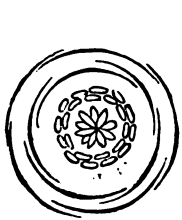


Fig. 17.

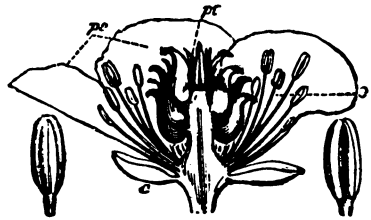


Fig. 18. Fig. 16. Fig. 19.

carpels numerous, one-celled (fig. 16, *pi*), usually distinct; ovary containing one inverted ovule (fig. 20, *g*), or several united to the inner edge. Fruit various, either achenes (fig. 21) or follicles, sometimes succulent. Seeds with hard albumen, erect or pendulous; embryo small (fig. 21, *e*). Herbaceous, rarely shrubby plants, having simple, often much divided leaves, with sheathing stalks. Juice watery. The plants of the order are found in cold, damp climates, and in the elevated regions of warm countries. The order has narcotico-acrid properties, and

Figs. 16 to 22 exhibit the organs of fructification of a *Ranunculus*, to illustrate the natural order Ranunculaceæ.

Fig. 16.—Flower cut vertically. *c*, Calyx. *pe*, Petals. *e*, Stamens. *pi*, Pistil composed of several carpels on a receptacle or axis.

Fig. 17.—Diagram of the flower, showing five imbricated sepals (*i.e.*, lying over each other like tiles on a house), five petals alternating with the sepals, indefinite stamens in several whorls, and numerous carpels or achenes in the centre.

Fig. 18.—Adnate anther seen on the outer side. The anther is in this instance extrorse (opening on the back or outer side). In the pæony it is introrse (opening on the face or inner side).

Fig. 19.—Adnate anther viewed on the inside.

the plants are usually more or less poisonous. The acridity is frequently volatile. It varies in different parts of the plants, and at different seasons.

Fig. 20.

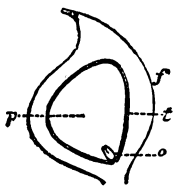


Fig. 21.

To illustrate the order, take the common buttercup, which belongs to the genus Ranunculus, and dissect it carefully. There are three species of Ranunculus called in common language buttercups :—(1) *Ranunculus bulbosus*, bulbous crowfoot (fig. 22), having its sepals reflexed, flowerstalks furrowed, and root bulbous ; (2) *Ranunculus repens*, creeping crowfoot, which has a stem with runners, its flowerstalks furrowed, its sepals not turned back, and its root not bulbous; (3) *Ranunculus acris*, upright meadow-crowfoot, which has its flowerstalks rounded (not furrowed), its sepals not turned back, and its root not bulbous.

Take the bulbous crowfoot, as shown in fig. 22. First there is seen the bulb at the base, from whence the roots are given off. This bulb must be regarded as a short thickened stem. From it the leaves proceed upwards and the roots downwards. There is a cluster of radical leaves ; each of these is cut into three stalked leaflets, which are again divided into three lobes. On the flowerstalks, a' a'' a''', are also seen cut leaves with narrower divisions. The peduncle, a, ends in a flower,

Fig. 20.—Vertical section of the ovary *o*, showing the erect ovule *g*. *s*, Stigma.

Fig. 21.—Fruit or achene cut vertically. *f*, Pericarp. *t*, Spermoderm or integument of the inverted seed. *p*, Perisperm or albumen, between fleshy and horny. *e*, Minute embryo.

f', which terminates the first axis; the flower, f'', terminates the second axis, a''; and the flower, f''', terminates the third axis, a'''. The peduncle below the flower is furrowed. The flower consists of calyx, corolla, stamens, and pistil. The five sepals of the calyx are

Fig 22.

turned down (reflexed), the five yellow petals have a pore at the base covered by a scale; the stamens are hypogynous, very numerous (twenty or more, indefinite), and consist of filaments and anthers which open on the side furthest from the pistil (extrorse). The pistil consists of numerous green carpels (fig. 20), each containing one ovule. These carpels, when ripe, form single-seeded seed-vessels (achenes), which do not burst, but fall to the ground entire. On making a section of the achene, the single erect seed is observed (fig. 21), containing a small

Fig. 22.—Ranunculus bulbosus. Bulbous crowfoot.

embryo and a quantity of white nourishing matter (albumen or perisperm). Some species of Ranunculus are distinguished by the leaves not being divided.

The Marsh Marigold (*Caltha*) is like a Ranunculus, but it has no corolla (only a calyx with yellow sepals), and the fruit consists of seed-vessels (follicles) which contain several seeds, and open on the side next the centre of the flower. The mode in which the sepals are arranged in the bud (æstivation) is the means of distinguishing clematis from anemone, which both belong to this order; in the former the æstivation of the calyx is valvate or induplicate (parts not overlapping each other), in the latter imbricate (overlapping).

In some Ranunculaceous plants—such as monkshood, larkspur, columbine, and hellebore—the sepals or petals, or both, are peculiar, and occur in the form of hollow tubes or spurs.

The next Thalamifloral order we shall take is also well represented in Britain, having the parts of the calyx and corolla, as well as the stamens, separate, but the carpels united together.

Order CRUCIFERÆ, the Wallflower and Cress Family (fig. 23.)—Sepals 4, deciduous. Petals 4, hypogynous, alternating with the sepals, deciduous, cruciate, or placed crosswise. Stamens 6, tetradynamous (figs. 25, 26), two shorter solitary (fig. 26 *e'*), four longer (fig. 26 *e''*) in 2 pairs. Green glands between the petals and stamens and the ovary (fig. 26 *g*). Ovary superior, with parietal placentas, which meet in the middle, forming a spurious dissepiment (replum) (fig. 27 *c*); stigmas 2 (25 *s*). Fruit a siliqua (figs. 28, 29), or a silicula, opening by two valves, which separate from the replum. Seeds attached in a single row by a short stalk to each side of the placentas; no albumen; embryo with the radicle folded upon the cotyledons.—Herbaceous plants, with alternate leaves, and yellow or white, rarely purple, flowers, without bracts. This order is well distinguished by its tetradynamous stamens and its

fruit. Most of the plants belonging to this order are European.

Fig. 23.

Fig. 24.

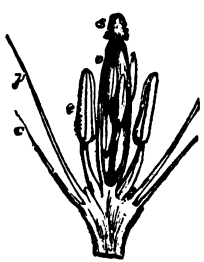


Fig. 25.

Fig. 26.

Fig. 23. Cruciferous flower of Wallflower (*Cheiranthus Cheiri*). *c*, Sepals. *p p*, Petals arranged like the parts of a cross. *e*, stamen.

Figs. 24-31.—Organs of fructification of *Erysimum lanceolatum*, one of the Cruciferæ.

Fig. 24.—Diagram of the flower, showing the arrangement of four sepals, four petals alternating with them, six tetradynamous stamens, and a siliqua with replum in the centre.

Fig. 25.—Vertical section of the flower. *c*, Calyx. *p*, Petals. *e*, Stamens. *o*, Ovary laid open. *s*, Stigma.

Fig. 26.—Flower deprived of its envelopes. *c c*, Scars left by the fall of the sepals. *g*, Glands which are situated at the base of the stamens. *e'*, Two short stamens. *e''*, Four long stamens in two pairs. *p*, Pistil.

The order has been subdivided into sections, according to the mode in which the radicle of the embryo is folded on the cotyledons, as well as according to the nature of the fruit. The distinctive characters taken from the embryo are minute, but they can be seen in the ripe seed on removing the outer cover-

Fig. 28.

Fig. 29.

Fig. 27.

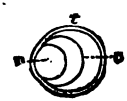


Fig. 31.

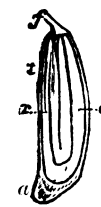


Fig. 30.

ing. As the embryo occupies the whole of the interior of the seed, it is seen whenever the coat of the seed is taken off. Thus, take the entire ripe seed of mustard as sold in the shops, and after soaking it in warm water, remove the outer covering, and the little embryo will fall out. By the naked eye,

Fig. 27.—Horizontal section of the ovary. *g*, Ovules. *c*, Spurious dissepiment (replum) which divides the ovary into two cavities. This replum is formed by the placentas.

Fig. 28. Sliqua or long pod.

Fig. 29. Siliqua with one of its valves removed, in order to show the seeds attached to the sides of the replum.

Fig. 30. Vertical section of the seed. *f*, Small stalk. *t*, Covering of seed swollen at the nourishing point, *a*. *r*, Radicle, *c*, Cotyledons.

Fig. 31.—Horizontal section of the seed. *t*, Covering of seed. *r*, Radicle. *c*, Cotyledons with radicle on their back.

or by means of a lens, the cotyledons may be seen folded on the small root (radicle). The radicle in other cases lies on the edge of the cotyledons, which are not folded (fig. 30), while at times it lies on the back of the cotyledons (fig. 31).

As regards the fruit, there are marked differences in cruciferous plants. The pod may be long and narrow (a siliqua), with two valves opening lengthwise, when the fruit is ripe, as in wallflower; or it may be short (a silicula), with the partition in its broader diameter, with flat or convex valves, as in whitlow grass; or it may be a short pod, with the partition in its narrower diameter, on account of the valves being each folded, as in shepherd's-purse; or it may be a pod divided by transverse partitions, each division containing one seed, as in the radish; and at times the pod is short and contains only one seed, as in woad. In books describing British plants you will find cruciferæ systematically arranged according to these characters.

There are no poisonous plants in the order. Many of the most common culinary vegetables belong to it, such as cabbage, cauliflower, turnip, radish, cress, horse-radish, etc. They contain much sulphur and nitrogen, and, on this account, when decaying, give off a disagreeable odour. Many garden flowers, such as wallflower, stock, rocket, and honesty, are found in this order.

Many common weeds serve as illustrations. Let us take the common wallflower (*Cheiranthus Cheiri*). It is a somewhat shrubby plant, growing often on rocks and walls. The leaves are narrow and tapering to each end (lanceolate), not divided, and covered with closely-adpressed hairs, which, when examined by the lens, are found to be forked. The flowers are on stalks, and their inflorescence is a raceme or a corymb. The sepals are 4, erect, and 2 of them are enlarged at the base. The petals are usually yellow, 4, arranged crosswise, with the lower part (claw) narrow. There are 4 long and 2 short stamens, which are hypogynous. The fruit is a siliqua, with a

short style surmounted by a stigma, which has 2 spreading lobes. The radicle of the embryo lies at the edges of the 2 cotyledons, marked thus O =, where is the radicle, and = the cotyledons.

The common stock (*Matthiola*) differs from the wallflower chiefly in having the lobes of the stigma not spreading, and either thickened at the back, or with a horn at the base.

The common mustard of the fields (*Sinapis arvensis*) is another cruciferous plant, with a siliqua which can be easily examined.

To illustrate the division with short pods and a broad replum, take the common scurvy grass of the sea-shore (*Cochlearia officinalis*). In this plant the radical leaves are somewhat kidney-shaped and stalked, while those of the stem are oblong and have no stalks. The flowers are white. The pod is oval or globular; its valves very convex, with a prominent rib in the middle; the seeds are numerous. The plant called honesty in gardens shows this division well. In the shepherd's-purse (*Capsella Bursa-pastoris*) you have an example of the division in which the plants have short pods and a narrow replum. The radical leaves—*i.e.*, the leaves at the base—are often pinnatifid, the upper ones embrace the stem; the leaves are very varied in their form. The flowers are small and white. The fruit is a triangular silicula, with a heart-like division at its apex (obcordate). The valves are boat-shaped, and not winged as in penny-cress (*Thlaspi*). The seeds are many and attached to the narrow replum. The jointed charlock or wild radish of the corn-fields (*Raphanus Raphanistrum*) shows a peculiar jointed or beaded siliqua, each of the joints containing one seed.

We next take a family in which there are marked irregularities in the flower, and a cohesion of the stamens, which at once separate it from those already illustrated.

Order VIOLACEÆ, the Violet Family. Sepals 5, persistent, usually elongated at the base. Petals 5, unequal, lower one spurred (fig. 33). Stamens 5, anthers 2-celled,

cohering, with a prolongation at the top and two projecting processes below (fig. 34). Ovary unilocular; style single, slightly curved, with an oblique hooded stigma (fig. 34, *s*). Fruit a 3-valved capsule, opening by three

Fig. 32.

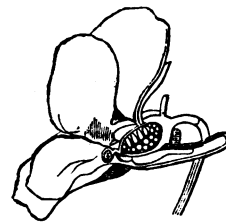


Fig. 33.

Fig. 34.

Fig. 35.

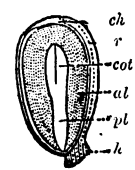


Fig. 36.

Figs. 32 to 36 illustrate the natural order Violaceæ.

Fig. 32.—Diagram of the flower of the Pansy, having five sepals, five petals, five stamens with appendages, a three-valved fruit with parietal placentas.

Fig. 33. — Section of the flower of a Violet, showing the spurred petal, with a staminal appendage within it, and the ovary with numerous ovules.

Fig. 34. — Five stamens of a Violet united by their anthers, two of them with long filiform appendages, *a*; obliquely hooded stigma in the centre, *s*.

Fig. 35.—Fruit of the Pansy opening in a loculicidal manner by three valves. Seeds numerous in the middle of the valves.

Fig. 36.—Anatropal seed of the Pansy cut vertically, showing the straight embryo, *pl*, with the cotyledons, *cot*, in the midst of albumen, *al*. The hilum is marked *h*, the chalaza *ch*, and the raphe *r*.

valves, placentas on the middle of the valves (fig. 35). Seeds numerous; embryo straight in the axis of fleshy albumen (fig. 36). Herbs or shrubs, with alternate, rarely opposite, leaves, having persistent stipules. They are natives of Europe, Asia, and America.

To illustrate this order, take the common wild pansy (*Viola tricolor*). This species is the origin of all the cultivated varieties of pansy. The stem is angled and branched, and bears oblong crenate leaves; the stipules are pinnatifid, with a large lobe at the end; the sepals are 5, and they are prolonged at the base so as to project downwards; the corolla consists of 5 petals of different sizes, the lower one having a hollow spur; the stamens are 5, united by their anthers, and two of the lobes send long processes into the hollow spur of the corolla. The upper petals are purple, the lateral bluish, and the lower one yellow, hence the name tricolor (three-coloured). There are several other species of British violet, such as the dog-violet, the wood-violet, the hairy violet, the March violet, or the sweet violet. They are distinguished by their leaves, stipules, peduncles, and antherine spurs.

The next Thalamifloral family to which we call attention, is one which contains many common weeds found in the garden, the fields and woods, as well as by river-banks and road-sides.

Order CARYOPHYLLACEÆ, the Carnation and Chickweed Family.—Sepals 4-5 (fig. 37), separate, or united in a tube (figs. 38 *c*, 45 *c*), persistent, *i.e.*, remaining after the flower withers. Petals 4-5 (fig. 45 *p*), with a claw often bifid or bipartite. Stamens (fig. 38 *e*) usually double the number of the petals. Ovary single, often stalked (fig. 38 *g*), composed of 2 to 5 carpels (fig. 39), which are usually united by their edges; stigmas 2-5 (fig. 38 *s*). Capsule unilocular (figs. 44, 40,) 2-5-valved, opening either by valves, or more commonly by twice as many teeth as stigmas (figs. 40, 42); placenta in the axis of the fruit (fig. 40, *p*). Seeds numerous,

with mealy albumen, and the embryo surrounding it (fig. 41). — Herbs, with opposite, entire, exstipulate leaves, and definite inflorescence (fig. 43). They inhabit chiefly temperate and cold regions. The order has been

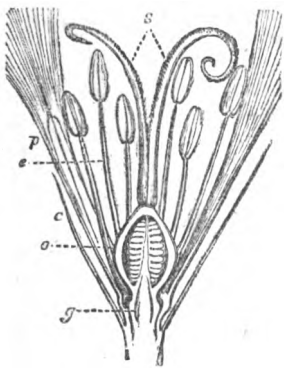
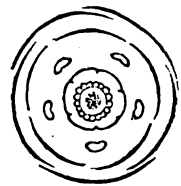


Fig. 38.



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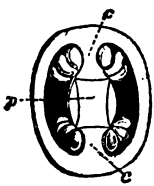


Fig. 39.

divided into two sub-orders—viz., 1. *Alsineæ*, sepals distinct (fig. 43); 2. *Sileneæ*, sepals cohering (fig. 45).

Figs. 37 to 45.—Illustrations of the natural order Caryophyllaceæ.

Fig. 37.—Diagram of the flower of *Stellaria media*, common Chickweed, belonging to the natural order Caryophyllaceæ, sub-order Alsineæ. The flower consists of five imbricate sepals, five alternate petals, five stamens, a unilocular ovary, with a free central placenta, and numerous ovules.

Fig. 38.—Section of the flower of *Dianthus Caryophyllus*, Carnation, belonging to sub-order Sileneæ. *c*, Gamosepalous calyx; *p*, petals, cohering with the stamens at the base; *e*, stamens; *g*, gynophore or thecaphore, *i.e.*, the stalk supporting the ovary; *o*, ovary with central placenta and ovules; *s*, two stigmas, which have papillæ all along their inner surface.

Fig. 39.—Horizontal section of the ovary in a very young state, showing the partitions, *c c*, which divide the ovary into two cavities. These divisions ultimately disappear, leaving the placenta, *p*, bearing the ovules, free in the centre.

The plants of the order are usually insipid. The greater part of them are weeds, but some are showy garden flowers. To the latter belong the varieties of carnation or clove-pink, picotees, bizarres and flakes, and numerous species of pink and campion.

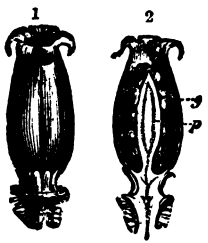


Fig. 40.

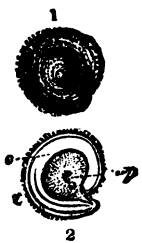


Fig. 41.

Fig. 42.

The order Caryophyllaceæ may be illustrated by many common British plants. In the sub-order Alsineæ we meet with the common narrow-leaved mouse-ear chickweed (*Cerastium triviale*). The stem is hairy and viscid, and bears leaves somewhat lanceolate in form. The inflorescence is a definite corymb—the central flower expanding first, and each axis dividing into two. The calyx consists of 5 sepals, which are as long as the small flower-stalk and the corolla, but only about half the length of the curved fruit. Petals are 5, cloven; stamens 10, inserted below the ovary; pistil composed of 5 united carpels, with 5 styles. Fruit opening at the top by 10 teeth. The mode of inflorescence is seen in fig. 43.

Fig. 40.—Capsule of *Lychnis githago* at the period of dehiscence, cut vertically, to show the seeds, *g*, grouped in a mass, on a free central placenta, *p*. 1, capsule entire; 2, capsule cut lengthwise.

Fig. 41.—1, Seed entire; 2, seed cut vertically. *t*, Spermoderm, or covering of the seed. *c*, Peripherical embryo, surrounding the mealy albumen, *p*.

Fig. 42.—Capsule or dry seed-vessel of *Cerastium triviale*, after dehiscence. *c*, Persistent calyx. *p*, Pericarp dividing at the apex, *v*, into ten teeth, which indicate the summits of as many valves united below.

which shows the flower-stalk and flower of species of Cerastium; and the seed-vessels are seen in fig. 44.

Fig. 43.

Another plant common in woods, which illustrates this division of the Caryophyllaceæ, is the greater stitchwort (*Stellaria Holostea*). It has a nearly erect stem, with sharp and rough angles, and bears lanceolate leaves drawn out into a point, placed opposite to each other. The flowers are large and white; calyx of 5 sepals; corolla of 5 deeply-cleft petals, which are twice as long as the sepals; stamens 10; pistil with 3 styles, and capsule opening with 6 teeth. The common chickweed (*Stellaria media*) is distinguished by its ovate or egg-shaped leaves.

In the sub-order Sileneæ, the plant most easily examined is the common red campion (*Lychnis dioica*). In this case we meet with staminate flowers on one plant and

Fig. 43.—Inflorescence of *Cerastium grandiflorum*. *b b b*, Opposite bracts produced at each of the branchings. The letters, *a* accented, mark the primary, secondary, tertiary, and quaternary axes. The primary axis, *a'*, ends in a flower which has passed into fruit. Inflorescence determinate. Evolution of flowers centrifugal.

pistillate flowers on another plant. The plant is therefore called dicœcious. It has a stem 1-2 feet high, bearing ovate acute leaves. Inflorescence definite. Sepals 5, united. Petals 5, pink-coloured, cleft, and with a crown, *i.e.*, scales near the upper part of the petals. Styles in the pistillate flower, 5. Capsule opening by 10 recurved teeth. Placenta in the axis covered by numerous seeds (fig. 44.) The common pink (*Dianthus*) is distinguished by its 2 styles, seed-vessel opening by 4 teeth, and scales at the base of the calyx. These characters are shown in the carnation (fig. 45). The catchfly (*Silene*) has 3 styles and 6 teeth in its seed-vessel.

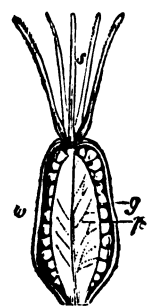


Fig. 44.

Fig. 45.

Attention is called to the natural order Malvaceæ, the Mallow family, and the natural order Geraniaceæ, the Geranium or Cranesbill family, which are characterized in part by the cohesion of the filaments of the stamens, so that the plants are Monadelphous. The fruit consists of several dry carpels, each containing one or

Fig. 44.—Pistil of *Cerastium hirsutum* cut vertically. *o*, Unilocular or one-celled ovary. *p*, Free central placenta. *g*, Ovules. *s*, Styles.

Fig. 45.—Polypetalous flower of *Dianthus monspessulanus*. *b*, Scales at base of calyx. *c*, Calyx. *p p*, Petals with their claws, *o*, approximated.

more seeds. In geranium there are 5 styles attached to a central beak-like axis from which they separate by curling from below upwards, carrying the seed-vessels with them.

QUESTIONS.

1. What is meant by phanerogamous plants?
2. Give the character of the class Dicotyledons.
3. Define the sub-classThalamifloræ.
4. Give the essential characters of the natural order Ranunculaceæ.
5. Describe the fruit of the crowfoot family.
6. How do the anthers of crowfoots open?
7. What are the species of ranunculus called buttercups? Separate them from each other.
8. Mention some of the Ranunculaceæ in which the corolla is wanting.
9. Mention some irregularities in the petals of the crowfoot order.
10. Give the essential characters of Cruciferæ.
11. Mention the kinds of fruit which are met with in the cruciferous order.
12. Mention peculiarities in regard to the embryo of Cruciferæ.
13. On what characters are subdivisions of the order Cruciferæ founded?
14. Mention a few cruciferous British plants.
15. Give the essential characters of Violaceæ.
16. Mention a peculiarity in the petals.
17. Mention some peculiarities in the stamens.
18. Define Caryophyllaceæ, and mention some plants found in the order.
19. What are the subdivisions of the chickweed order? Give their characters.
20. Explain the mode in which the seed-vessels of the carnation and the red campion open.
21. What relation do the valves or teeth of the seed-vessels of Caryophyllaceæ bear to the styles?
22. What kind of inflorescence occurs in the chickweed or carnation order?

We now pass on to the second sub-class of Dicotyledonous plants.

Sub-Class II.—Calycifloræ.

In the plants belonging to this sub-class, calyx and corolla are present; the petals are distinct or united, and the stamens are attached to the calyx—being perigynous or epigynous.

Section 1.—Polypetalæ.—Petals separate, stamens attached to the calyx, perigynous or epigynous.

This section may be illustrated by the leguminous, rosaceous, and umbelliferous orders.

Fig. 46.

Fig. 47.

Order Leguminosæ, the Pea and Bean Family.—Calyx has five segments (fig. 47 *c c*), with the odd one inferior. Petals usually 5 (figs. 46, 47), and unequal, often papilionaceous, with the odd petal superior (fig. 47 *e*), stamens usually monadelphous or diadelphous (fig. 47 *t*).

Figs. 46-50.—Organs of fructification of *Lathyrus odoratus*, sweet-pea, a papilionaceous flower, showing the structure of the natural order Leguminosæ.

Fig. 46.—Diagram of the flower, showing five divisions of the calyx, 5 petals, consisting of 2 parts forming the carina, 2 alæ, and the vexillum (standard), which is superior; 10 stamens diadelphous; ovary 1-celled, formed by a single carpel; one of the ovules shown with its stalk attached to the ventral suture.

Fig. 47.—Longitudinal section of the flower of *Lathyrus odoratus*. *c c*, Calyx, with five segments. *e*, Vexillum or standard, being the superior petal. *a*, One of the alæ, or wings. *c a*, One-half of the carina, or keel. *t*, Tube of the stamens, the filaments being united in two bundles (diadelphous). *o*, Ovary laid open, showing the ovules attached to the placenta, on the ventral or upper suture. *s*, Stigma, at the apex of the style, which is continuous with the ventral suture.

Ovary superior, 1-celled, consisting usually of a solitary carpel (fig. 47 *o*). Fruit a legume (fig. 48). Seeds solitary or several (fig. 49); embryo exalbuminous (fig. 50).—Herbaceous plants, shrubs, or trees, with alternate, usually compound leaves, having two stipules at the base of the petiole. The flowers are frequently papilionaceous, and the fruit is leguminous; and by the presence of one or other of these characters the order may be recognised.

Fig. 48.

Fig. 49.

Fig. 50.

The plants of the order are widely distributed over the globe.

The order has been divided into three sub-orders:—

1. *Papilionaceæ;* papilionaceous flowers, petals imbri-

Fig. 48.—Fruit of pea, a legume or pod, formed by two valves, opening by the ventral and dorsal suture. Seeds attached on each side of the ventral suture, curved upon themselves, having a marked hilum and stalk.

Fig. 49.—A seed separated. *f*, Stalk of seed. *c*, Point where nourishing vessels reach the embryo. *m*, Opening in seed.

Fig. 50.—Embryo, which occupies the entire seed after the covering is removed. *c c*, Two cotyledons separated: in this case they are fleshy and remain under ground during germination. *g*, Young stem. *r*, Radicle.

cated in æstivation, and upper one exterior. *Examples*—Broom, pea. 2. *Cæsalpinieæ;* flowers irregular, petals imbricated in æstivation, upper one interior. *Examples*—Cassia, logwood. 3. *Mimoseæ;* flowers regular, petals valvate in æstivation. *Example*—Gum-arabic tree.

This is a very extensive and a very important natural order. It embraces many valuable medicinal plants, such as those yielding senna, gum-arabic, tragacanth, catechu, and kino; important dyes, as indigo and logwood; many valuable timber-trees, as locust-tree and rosewood; plants furnishing nutritious food, such as the bean, pea, and clover. The properties of the order may be considered in general as wholesome, although it contains some poisonous plants, such as the Calabar bean.

All the British leguminous plant belong to the sub-order Papilionaceæ, having pea-like blossoms. To illustrate the order, we shall take the common broom (*Sarothamnus scoparius*). The broom is a shrubby plant, having a stem 2 to 3 feet high, with angular smooth branches; the leaves are stalked, and are arranged in threes (ternate); the upper ones, however, are simple (not compound); the leaflets are inversely egg-shaped. The flowers are large, bright yellow, and are either solitary or in pairs, with short stalks; the calyx is two-lipped, the upper lip having two minute teeth, the lower three; the standard is large, and covers the other parts of the flower in bud; the keel is blunt, and finally falls down; the stamens are monadelphous, and their tube is split on the upper side; the style is long, curved, and thickened upwards towards the stigma, which is small and like the head of a minute pin; the pods are dark-brown and hairy at the edges, containing many seeds, and when ripe they open in an elastic manner, and often with a marked noise.

Most of the British plants in the order are diadelphous. This character is seen in the vetches, the everlasting pea, the trefoils, and the bird's-foot trefoil, in which there are nine stamens united by their filaments, and one

separate. The leaves of the British species are either solitary, or they are ternate or pinnate. Pea-blossoms and legumes are present in all the British plants of the order.

Order ROSACEÆ, the Rose Family (figs. 51 to 61).—Calyx 4-5-lobed (fig. 52 *c c*), the fifth lobe superior. Petals as many as the divisions of the calyx, often 5 (fig. 52 *pe*), sometimes wanting, generally regular. Stamens

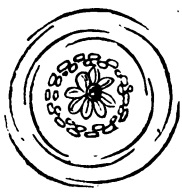


Fig. 51.

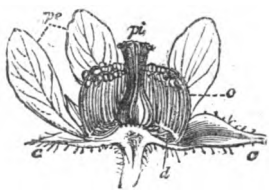


Fig. 52.

Fig 53.

perigynous, definite or indefinite (fig. 52 *e*). Ovaries superior, either solitary or several, one-celled (fig. 54). Fruit, achenes (fig. 60), or drupes (fig. 55), or follicles, or apples.—Herbaceous plants, or shrubs, or trees, with simple or compound, alternate, stipulate leaves. They are found chiefly in the cold and temperate climates of the northern hemisphere. Some are found on high mountains within the tropics, and a few occur in warm regions. The superior odd lobe of the calyx distinguishes this order from Leguminosæ.

The order has been divided into the following sub-orders:—1. *Roseæ;* calyx-tube, becoming fleshy and cover-

Figs. 51-58.—Organs of fructification of a kind of bramble (*Rubus strigosus*), illustrating the natural order Rosaceæ.

Fig. 51.—Diagram of the flower; five divisions of the calyx, with its fifth lobe superior, 5 petals, indefinite perigynous stamens, and numerous carpels.

Fig. 52.—The flower cut vertically. *c c*, Calyx. *pe*, Petals. *e*, Stamens. *d*, Disk, lining the base of the calyx, upon which the stamens are inserted. *pi*, Pistil composed of several carpels.

Fig. 53.—Anther separated, with the upper part of the filament seen on the outside.

ing numerous hairy achenes (fig. 59.) *Example*—Rose. 2. *Potentilleæ;* fruit consisting of numerous achenes on an elevated receptacle. *Example*—Strawberry. 3. *Sanguisorbeæ;* petals 0, stamens definite, often 4 (fig. 61). *Example*—Lady's-mantle. 4. *Amygdaleæ;* styles terminal, fruit a drupe. *Example*—Cherry. 5. *Spiræeæ;*

Fig. 54.

Fig. 55.

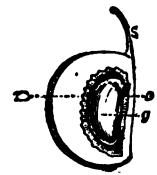


Fig. 56.

Fig. 57.

Fig. 58.

fruit consisting of numerous follicles. *Example*—Queen of the meadow. 6. *Pomeæ;* fruit a 1-5-celled fruit like the apple (pome). *Example*—Apple.

Many of the plants of the order yield edible fruits, such as raspberries, strawberries, brambles, plums, apples, pears, quinces, cherries, almonds, peaches, nectarines, and apricots. Some are astringent, others yield prussic acid.

We shall illustrate the order, in the first place, by the genus Rosa, which is easily distinguished by its fruit, commonly called the hep of the rose. This fruit consists of the calyx, with a fleshy covering inside, bearing numerous hairy achenes, each terminated with a long style.

Fig. 54.—Ovary, *o*, cut vertically. *g*, Suspended seed. *s*, Lateral style.

Fig. 55.—Fruit. *f*, Succulent carpels with the persistent calyx, *c*, connected with which the withered filaments are seen.

Fig. 56.—Vertical section of a carpel. *s*, Lateral style. *m*, Mesocarp. *e*, Endocarp. *g*, Seed.

Fig. 57.—Horizontal section of the exalbuminous seed. *t*, Integument. *c*, Cotyledons of the embryo.

Fig. 58.—Embryo isolated. It fills the entire seed.

The tube of the calyx is contracted at its orifice, and the limb of the calyx is seen on the top of the hep. The roses have prickly stems, pinnate leaves, with stipules coherent to the leaf-stalk. The Burnet rose is the common Scotch rose, found abundantly on sandy soils. The dog-rose, the sweetbrier (fig. 59), the downy-leaved rose, and many other species, belong to the genus.

Fig. 59.

Fig. 60.

Examine the common wild strawberry (*Fragaria vesca*), and you will find a short stem sending off runners, which root as they extend, bearing ternate leaves; flowering stem erect, and producing few flowers; a double calyx with five large and five small segments alternating; five petals; numerous stamens adhering to the calyx; single-seeded carpels on the top of a succulent receptacle; styles lateral, arising from near the base of the ovary (fig. 60). In the strawberry the edible part is the juicy receptacle, whereas in the raspberry the receptacle is not eaten, but

Fig. 59.—Polypetalous flower of *Rosa rubiginosa*, the sweet-brier. *b*, Bract or floral leaf. *ct*, Tube of calyx, which forms the conspicuous part of what is commonly called the fruit. *cf*, *cf*, *cf*, *cf*, Sepals of the calyx. *p p p p*, Petals, without a claw. *e*, Stamens attached to the calyx.

Fig. 60.—Carpel of strawberry. *o*, Ovary. *t*, Style arising from near the base, and becoming basilar by the mode in which the ovary is developed; the style, however, still indicating the organic apex of the ovary.

the succulent carpels are used. The cinquefoil (*Potentilla*) differs from the strawberry in having a dry receptacle. In the lady's-mantle (*Alchemilla vulgaris*, fig. 61) the corolla is wanting, the parts of the flower are arranged in fours, the fruit consists of a single achene, and the style

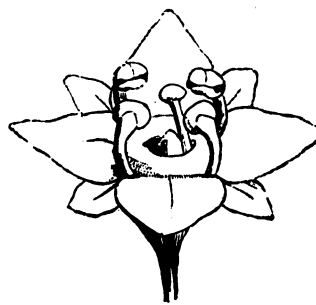


Fig. 61.

is lateral; the leaves are rounded and plaited, and from 7-9-lobed. The cherry and peach have drupaceous fruit; the apple and pear have fleshy fruit formed of five carpels, and the queen of the meadow (*Spiræa*) has follicles for its fruit.

Order UMBELLIFERÆ, the Hemlock Family (figs. 62-66).—Calyx superior, 5-toothed or entire. Petals 5, inserted on the outside of a fleshy epigynous disk, often with inflexed points (figs. 63, 64). Stamens 5, alternate with the petals (figs. 63, 64). Ovary inferior, 2-celled, crowned with a double disk (64 *ge*); ovules solitary, pendulous; styles 2, distinct (fig. 64 *s*). Fruit (figs. 65, 66) formed by two achenes, which adhere by their faces to a common axis, from which they separate and are suspended when ripe (fig. 67); each achene is traversed by ridges. In the substance of the covering of

Fig. 61.—Flower of Lady's-mantle (*Alchemilla vulgaris*), with a double calyx of 8 parts, four stamens, a basilar style, and a thick ring in the throat of the calyx.

the fruit there are frequently oil-cavities, called vittæ. Seeds pendulous (fig. 66 *g*), embryo minute, at the base

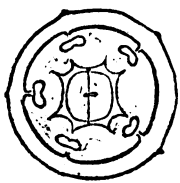


Fig. 62.

Fig. 63.

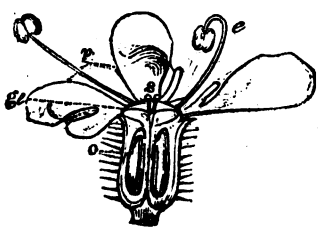


Fig. 64.

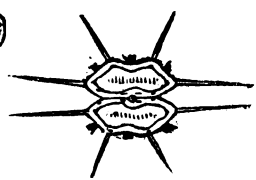


Fig. 65.

of abundant horny albumen (fig. 66 *e*). — Herbaceous plants, often having hollow and furrowed stems, with alternate, rarely opposite, variously divided, sheathing leaves,

Figs. 62-66. — Organs of fructification of the common carrot (*Daucus Carota*), to illustrate the natural order Umbelliferæ.

Fig. 62.—Diagram of the flower, with a 5-toothed calyx, 5 inflexed petals, 5 stamens, and fruit formed by two carpels, with ridges and albumen.

Fig. 63.—The flower viewed from above, showing the petals with inflexed points and 5 stamens. *ge*, Epigynous disk.

Fig. 64.—Vertical section of the flower. *p*, Petals with inflexed points. *e*, Stamens, one incurved at the apex. *o*, Ovary formed by two carpels, adherent to the calyx throughout. *s*, Styles and stigmas. *ge*, Epigynous disk or stylopod.

Fig. 65.—Horizontal section of the fruit (cremocarp) with bristly ridges.

and umbellate flowers. They are found chiefly in the northern parts of the northern hemisphere. In warm countries they occur at high elevations. The order has been divided according to the number and size of the ridges on the fruit, the presence or absence of vittæ, and the form of the albumen.

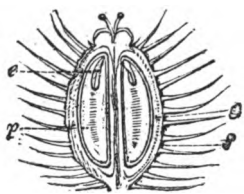


Fig. 66.

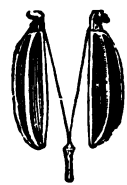


Fig. 67.

The properties of the plants of this order are various. Some yield articles of diet, others gum-resins and oily substances, while others are highly poisonous. According to their qualities, the species have been divided into— 1. Those which are harmless, and are used as esculent vegetables—carrot, parsnip, and parsley. 2. Those producing a gum-resin, often having a fetid odour from the presence of a sulphur-oil, and which are used as antispasmodic and stimulants—assafœtida and galbanum. 3. Those yielding a volatile oil, which renders them carminative and aromatic—caraway, coriander, anise, cummin. 4. Those which are poisonous, in consequence of the presence of an acrid and narcotic juice—hemlock and fool's parsley.

Many native plants may be used to illustrate the Umbel-bearing family. In the early months of summer the chervil (*Anthriscus*) and the cicely (*Myrrhis*) will

Fig. 66.—Vertical section of the fruit. *f*, Pericarp. *g*, Suspended seeds. *p*, Flat albumen. *e*, Embryo.

Fig. 67.—The fruit of Fennel, separating into 2 achenes (mericarps) suspended by the split carpophore. Styles, stylopod, and the ridges of the fruit are seen.

answer the purpose well. It is of importance to see the fruit fully formed, and hence the characters of the plants are best seen later in the season. The sweet cicely (*Myrrhis odorata*), which is common on the banks of streams, may be taken as an illustration, more especially as from its early flowering it perfects its fruit sooner than others. It is a highly aromatic plant, two or more feet in height. The leaves are large, thrice-pinnate, and the leaflets are pinnatifid. The leaves are downy below, and they are marked above by white spots or patches. The flowers are white, arranged in compound umbels. The calyx-limb is very minute and scarcely visible. The petals are inversely heart-shaped, with a turned-in point. The fruit is large, composed of two achenes united, which when ripe separate, and are for a time suspended by their apex, by means of thread-like cords. The covering of the achenes is double, the inner one being close to the seed, the other being folded into hollow ridges. At the top of the fruit the disk and two styles are easily observed. By cutting across the fruit the white curved albumen will be seen.

QUESTIONS.

1. Give the characters of the sub-class Calycifloræ.
2. Give the characters of the section Polypetalæ.
3. Give the characters of Leguminosæ, including calyx, corolla, stamens, and fruit.
4. What kind of corolla is found in the British leguminous plants? Give an example.
5. What are the sub-orders of Leguminosæ?
6. Give the essential characters of these sub-orders.
7. Give an illustration of each of the sub-orders.
8. What are the properties of Leguminosæ?
9. Mention a poisonous plant of the order.
10. Mention a peculiarity in the mode in which the legume of the broom opens.
11. Give the character of the style of the broom.
12. What kind of stamens are met with in the British leguminous plants?

13. Mention some common leguminous plants used for food.
14. What kind of leaves are most commonly met with in leguminous plants?
15. Give the characters of the natural order Rosaceæ.
16. How is the calyx of Rosaceæ distinguished from that of Leguminosæ?
17. What kind of fruit occurs in Rosaceæ?
18. Mention the sub-orders of Rosaceæ.
19. Give the essential characters of each of the sub-orders.
20. Mention plants illustrating each of the sub-orders.
21. What are the usual properties of the plants belonging to the order Rosaceæ?
22. Give a description of the hep of the rose.
23. Explain the difference between the fruit of the strawberry and that of the raspberry.
24. Mention a peculiarity in the style of the strawberry.
25. What constitutes the succulent part of the strawberry, and what does it bear on its surface?
26. How does the fruit of the common cinquefoil differ from that of the strawberry?
27. Mention a peculiarity in the flower of the common lady's-mantle.
28. Give the essential characters of the umbelliferous order.
29. Whence is the name derived?
30. Give the characters of the fruit of Umbelliferæ, and describe the mode in which it is scattered.
31. What is meant by the vittæ of umbelliferous plants?
32. What are the properties of Umbelliferæ?
33. Mention plants illustrating different properties in the order.
34. Give the characters of the fruit of the sweet cicely.

We proceed to consider the second section of the subclass Calycifloræ.

Section 2.—GAMOPETALÆ.—Petals united; stamens usually epigynous. This section includes the orders with united petals, in which the ovary is inferior, or, in other words, in which the calyx is superior. This section will be illustrated by the harebell and composite orders.

Order CAMPANULACEÆ, the Harebell Family (figs. 68-75).— Calyx superior, usually 5-lobed (figs. 69, 70 *c*), persistent. Corolla gamopetalous, usually 5-lobed, regular, withering on the stalk. Stamens inserted into the calyx,

alternating with the corolline lobes, and equal to them in number; anthers free (fig. 70 *e*). Ovary inferior, composed of two or more carpels; ovules indefinite (fig. 71).

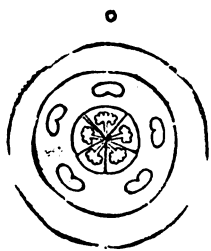


Fig. 68.

Fig. 69.

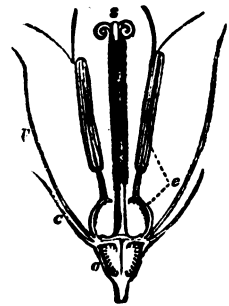


Fig. 70.

Fruit capsular, crowned with the withered calyx and corolla (fig. 72), opening by lateral apertures, or at the apex. Seeds attached to a central placenta; embryo straight, in the axis of fleshy albumen; radicle pointing to the base of the seed (figs. 73-75).—Milky herbs or undershrubs, with alternate, rarely opposite, exstipulate leaves. The flowers in most instances belong to the blue series. They are natives chiefly of northern and temperate regions. They abound in the alpine regions of Europe and Asia, and are also frequent in North America. The milky juice found in the plants of this order has acrid

Figs. 68-75. — Organs of fructification of Rampion (*Campanula Rapunculus*), to illustrate the natural order Campanulaceæ.

Fig. 68.—Diagram of the flower, showing five divisions of the calyx, five divisions of the corolla alternating with them, five alternating stamens, and five cells of the ovary.

Fig. 69.—Flower-bud. *c*, Calyx above the ovary. *p*, Corolla, with valvate æstivation.

Fig. 70.—Vertical section of the flower. *c*, Calyx above the ovary, *o*. *p*, Gamopetalous corolla. *e*, Stamens with bilocular anthers. *s*, Lobed stigma at the apex of the style, which is covered with collecting hairs. *o*, Ovary containing numerous ovules, attached to a central placenta.

properties. The roots and young shoots of rampion (*Campanula Rapunculus*) are used as articles of diet.

Fig. 71.

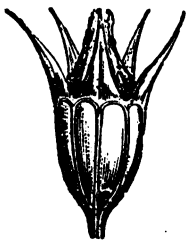
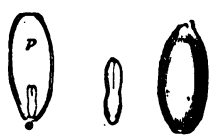


Fig. 72.



Figs. 73. 74. 75.

The Campanulaceæ can be most easily illustrated by the common harebell of our fields, called *Campanula rotundifolia*. The specific name means round-leaved; but this character is not easily seen. It is only the lowest leaves that have this character, and they wither soon. These lower leaves are rounded, cordate, and have stalks; while the upper leaves are sessile and lanceolate or linear. The stem is from 6 to 12 inches high. The flowers are one or more, supported on stalks and drooping. The segments of the calyx are narrow. The corolla is bell-shaped, usually blue, sometimes white. The plant is commonly called in Scotland the blue-bell, a name which is given in England to the wild hyacinth.

Order COMPOSITÆ, the Dandelion and the Daisy Family (figs. 76-81).—Calyx superior, its limb usually divided into hairs, called pappus. Corolla gamopetalous,

Fig. 71.—Horizontal section of the ovary.

Fig. 72.—Fruit crowned by the calyx, dehiscing by openings at the base.

Fig. 73.—Seed in an entire state.

Fig. 74.—Seed cut vertically. *p*, Perisperm (albumen). *e*, Straight embryo in the axis of the albumen, with the radicle pointing to the hilum (base of seed).

Fig. 75.—Embryo detached, showing its form, the cotyledons, and radicle.

ligulate (fig. 76), or tubular (fig. 77), in the latter case usually 5-toothed. Stamens usually 5 (fig. 77 *e*); filaments distinct; anthers (figs. 76, 77 *e*) cohering into a cylinder (syngenesious). Ovary inferior, bearing the calyx on its

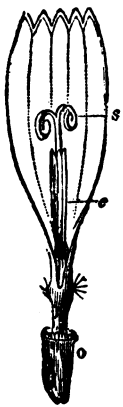


Fig. 76.

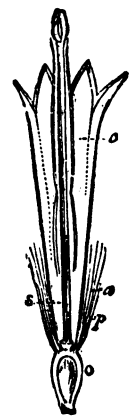


Fig. 77.

summit (figs. 76, 77 *o*, 79), 1-celled; ovule solitary (figs. 77, 79); style simple; stigmas 2 (fig. 76). Fruit, an achene, crowned with the calyx (fig. 79). Seed solitary, erect, exalbuminous (fig. 79).—Herbs or shrubs,

Figs. 76-79.—Organs of fructification of Compositæ.

Fig. 76.—One of the ligulate flowers or florets of *Cichorium Intybus*, Succory or Chicory, belonging to the sub-order Cichoraceæ. *o*, Ovary bearing the calyx on its summit, the limb of the calyx forming a crown surrounding the base of the ligulate (strap-shaped) corolla, which has five divisions at the top. *e*, Cylinder formed by the anthers (synantherous or syngenesious), traversed by the style with its bifid stigma, *s*.

Fig. 77.—Tubular flower of *Aster rubricaulis*, belonging to the sub-order Corymbiferæ, cut longitudinally, to show the erect ovule *o*, enclosed in the ovary; when ripe this forms an achene. *p*, United petals. *a*, Pappus, consisting of the altered calyx. *e*, Stamens with their united anthers, attached to the corolla. *s*, Style traversing the antherine tube.

with alternate or opposite, exstipulate leaves, and heads of flowers, called florets, which have either stamens and pistils together, or are pistillate and staminate, and are surrounded by bracts in the form of an involucre.

This is one of the largest, and, at the same time, one of the most important natural families in the vegetable kingdom. The plants were all included by Linnæus in his class Syngenesia. They amount to upwards of 10,000 species, and are variously distributed over all quarters of the world.

This order has been divided into three sub-orders :— 1. Cichoraceæ (*cichorium*, chicory), having the florets

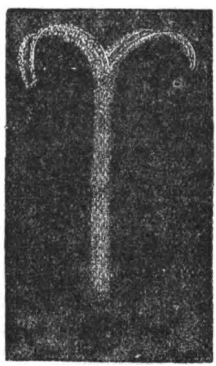


Fig. 78.

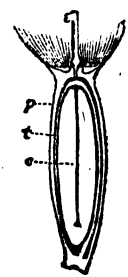


Fig 79.

all ligulate. 2. Cynarocephalæ (*cynara*, the artichoke), having the florets all tubular; style swollen below the point where it divides; involucre hard, conical, and often spiny. 3. Corymbiferæ (*corymbus*, a corymb), having tubular florets in the centre, and usually ligulate in the

Fig. 78.—Style of Vernonia with bifid hairy stigma.

Fig. 79.—Ripe fruit of a Senecio, cut vertically. *e*, Exalbuminous embryo. *t*, Spermoderm or covering of the erect seed. *p*, Pericarp, consisting of ovarian wall, with the seed in the interior. *s*, Style.

circumference; style not swollen, involucre hemispherical, leafy, or scaly, seldom spiny.

Sub-order *Cichoraceæ* (figs. 80, 81).—Most of the plants of this sub-order yield a milky juice, which is bitter, astringent, and sometimes narcotic. By cultivation some of them are rendered esculent. Chicory, dandelion, lettuce and hawkweed, are among the plants of this section.

Fig. 80.

Sub-order *Cynarocephalæ*. The plants of this sub-order are usually bitter and tonic. The bitterness is often much lessened by cultivation, and the plants become esculent. Thistles, burdock, and artichoke belong to this division.

Sub-order *Corymbiferæ*. The plants of this sub-order have the general bitterness of the order, and some of them have an aromatic odour, from the presence of volatile oil. Chamomile, coltsfoot, the sunflower, and the daisy, are among the plants of this section.

Fig. 80.—*Cichorium Intybus*, Chicory plant, with its compound flowers, and large root, which is roasted and mixed with coffee.

This large order may be illustrated by many common plants. We shall describe a plant in each of the divi-

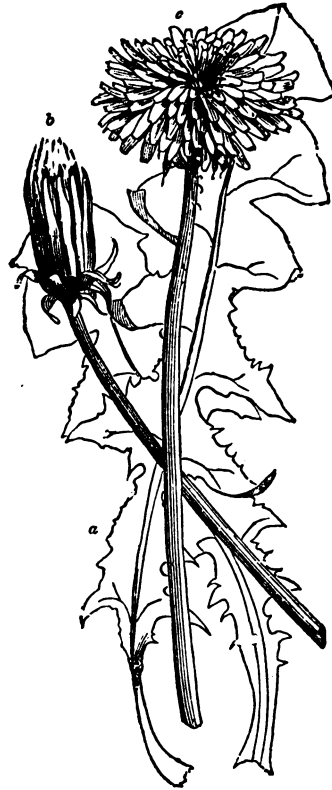


Fig. 81.

Fig. 81.—Runcinate leaves, *a*, and radical peduncles or multifloral scapes, *b c*, of Dandelion (*Leontodon Taraxacum.*) In the unexpanded head (capitulum) of flowers, the row of bracts forming the involucre is seen. The expanded head, *c*, consists of numerous ligulate florets, sessile on a flattened receptacle.

sions. The common dandelion (*Leontodon Taraxacum*), so called (*dent de leon*) from the tooth-like margins of its leaves, is a good example of the sub-order Cichoraceæ. In this plant the leaves are radical, and have a pinnatifid form, to which the name runcinate has been given, because the edges have divisions like the teeth of a saw pointing downwards. The stalk bearing the head of flowers is hollow, and arises singly from the midst of the radical leaves. The heads consist entirely of yellow ligulate flowers, surrounded by rows of bracts, the outer row becoming usually deflexed as the fruit ripens. The ligulate florets are situated on a receptacle, which is at first succulent, but afterwards becomes dry and convex in order to scatter the fruit. The calyx-limb consists of hairs at the top of the ovary. The corolla is ligulate, placed also above the ovary, and it encloses 5 stamens, with united anthers, forming a tube through which the style passes. The fruit is an achene, *i.e.*, a dry seed-vessel with a single seed, scattered by means of the pappus, which elongates so as to form a sort of parachute. The achene is suddenly contracted above, and forms a slender beak. The plant yields a milky juice, and its roots have been used instead of chicory.

The common thistle (*Carduus lanceolatus*) belongs to the sub-order Cynarocephalæ. The leaves are white and cottony below, pinnatifid, and the segments end in sharp spines; prolongations from the bases of the leaves run down the stem, which is from three to four feet high, and has strong spiny wings. The heads of flowers terminate the axes, and they are either solitary or two or three together. The bracts covering the heads of flowers are spiny, and form a united egg-shaped involucre. The florets are tubular, placed above the ovary. The hairs constituting the limb of the calyx are above the ovary, and are united into a ring at the base; they ultimately fall off and leave the fruit (achene) clear.

The common daisy (*Bellis perennis*) belongs to the sub-order Corymbiferæ. The leaves of the plant are

radical, that is, produced from a short stem, and lying along the ground; they are inversely ovate, and like a spatula in form, the margin being slightly divided. The stalk bearing the head of flowers arises from the centre of the radical leaves. The heads of flowers are surrounded by two rows of equal floral bracts. The florets are placed on a conical receptacle. There are two kinds of florets; the outer white florets (sometimes tipped with red) are ligulate, and have pistils only. The inner yellow florets are tubular, and have both stamens and pistils. The anthers are united round the style. There is no pappus. The fruit is compressed. After the fruit has fallen, the conical receptacle is well seen.

QUESTIONS.

1. Give the essential characters of the gamopetalous section of Calycifloræ.
2. Give the characters of Campanulaceæ.
3. Mention a peculiarity in the mode of opening in the capsule of the common harebell.
4. What kind of juice is met with in campanulas?
5. What plants receive the name of blue-bell?
6. Give the essential characters of Compositæ.
7. What is the usual character of the calyx of Compositæ? and what is its relation to the ovary?
8. What kind of fruit occurs in Compositæ?
9. What kinds of corolla are seen in Compositæ?
10. What is the inflorescence of Compositæ?
11. Give the characters of the anthers of Compositæ.
12. What are the properties of Compositæ?
13. Mention the sub-orders of Compositæ, and give an example of each.
14. Give the characters of these sub-orders.
15. In what sub-order is milky juice met with?
16. Describe the parts of the head of the dandelion.
17. Describe the parts of the head of a thistle.
18. Describe the parts of the head of the daisy.
19. What form of receptacle occurs in the daisy?

We now proceed to describe the third sub-class of dicotyledonous plants. It may be illustrated by the

heath, the borage, the potato, the dead-nettle, and the figwort orders. The characters of some of the orders will be put in contrast, so as to shorten the description and point out the chief marks of distinction between them.

Sub-Class III.—Corollifloræ.

Calyx and corolla present. Corolla gamopetalous, hypogynous, usually bearing the stamens.

We commence with the heaths, in which the stamens are usually not attached to the corolla.

Order Ericaceæ, the Heath Family (figs. 82-84).—Calyx 4-5-cleft, persistent. Corolla hypogynous (fig. 84), often withering on the stalk. Stamens equal in number to the segments of the corolla, or twice as many, inserted with the corolla, and either free from it or attached to its base; anthers 2-celled, usually having appendages at the base (fig. 84) or apex, dehiscing by pores or clefts at the top. Ovary free (fig. 84), many-celled; ovules numerous, attached to a central placenta; style 1, stigma 1. Fruit capsular or berried, many-celled. Seeds numerous, minute.—Shrubs, undershrubs, or herbaceous plants, with evergreen, often rigid, entire, verticillate or opposite, exstipulate leaves. The order contains many beautiful and showy plants, which abound at the Cape of Good Hope, and species of which are found also in Europe, North and South America, and Asia.

The plants of the order are not remarkable for medicinal virtues. There are six species of the genus *Erica* natives of Britain: two of these, *Erica cinerea* and *Erica Tetralix*, are common; two are peculiar to Ireland, *E. Mackaiana* and *E. Mediterranea;* and two are common to England and Ireland, *E. ciliaris* and *E. vagans*. The corollas of these heaths assume pink and white colours. *Calluna vulgaris* is the common heather, called ling. It has astringent qualities, and has been used for dyeing. It is commonly made into brooms. The leaves of *Arbutus*

(*Arctostaphylos*) *Uva-ursi*, bearberry, are used as an astringent. Some of the species of *Rhododendron*, *Azalea*, *Kalmia*, *Andromeda*, and *Ledum*, have poisonous narcotic qualities.

Fig. 82.

Fig. 83.

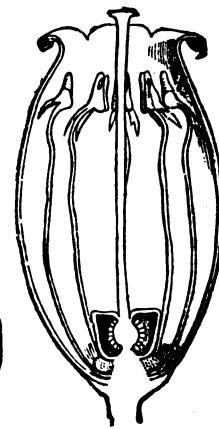


Fig. 84.

The order may be illustrated by the common heather and the bell-flowered heath. The common heather (*Calluna*) differs from the heath (*Erica*) in the mode in which its seed-vessel opens. In Calluna the openings take place through the partitions (septa), and the valves separate from the septa. In Erica the openings take place at

Figs. 82-84 illustrate the natural order Ericaceæ.

Fig. 82.—*Erica cinerea*, fine-leaved Heath, showing its entire exstipulate leaves and ovate swollen corolla with a 4-divided limb.

Fig. 83.—Diagram of *Erica*, showing a flower having 4 divisions of the calyx and corolla, 8 stamens, and a 4-valved capsule.

Fig. 84.—Vertical section of the flower of *Erica*, showing calyx, corolla, hypogynous stamens, anthers opening by slits, and having appendages below, and ovary with central placenta and numerous ovules.

the back of the cells of the capsule, between the septa, which remain attached to the centre of the valves. The common bell-heath (*Erica Tetralix*), called also cross-leaved heath, is shrubby; its narrow leaves are arranged in whorls of four; they are fringed with hairs, and are downy above, their edges being turned back. The flowers are arranged in an umbel-like form. Calyx divided deeply into 4. Corolla bell-shaped. Stamens 8, with spurred anthers. Seed-vessel 4-celled. Ovary hairy. The fine-leaved heath (fig. 82) is called *Erica cinerea*, and it differs from the cross-leaved heath in having ternate smooth leaves, racemose flowers, and a smooth ovary. The Epacris is called Australian heath. It differs from the true Erica in having 5 in place of 4 divisions of its corolla, and in having 1-celled in place of 2-celled anthers.

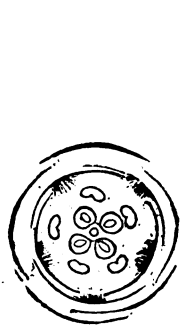
The blaeberry and cranberry family (*Vacciniaceæ*) differs from the heath family only in having the rows of the flower (calyx, corolla, and stamens) epigynous, that is, situated above the ovary. The family is therefore placed in Calycifloræ Gamopetalæ, and is the link which unites Calycifloræ and Corollifloræ.

To show the relations of some corollifloral orders, we shall now take two to illustrate the group with regular flowers, and two to illustrate the group with irregular flowers.

1. *Group of Corollifloral Plants with Regular Flowers.*

Order BORAGINACEÆ, the Borage Family (figs. 85-87).—In this order we have plants with a gamopetalous calyx, usually having 5 divisions, a regular 5-cleft corolla, 5 stamens attached to the corolla (fig. 86), and a 4-lobed ovary, which, when ripe, becomes 4 achenes (mericarps) (fig. 85.) This division of the ovary into four is peculiar, and, along with scorpioidal inflorescence and rough foliage, forms a distinguishing character of the order. It may be illustrated by the comfrey (*Symphytum tuberosum*),

common on river-banks, and the forget-me-not (*Myosotis*). One of the best plants for showing the four achenes forming the fruit, is the common hound's-tongue (*Cynoglossum officinale*), which is abundant on many of our sandy shores amongst bent-grass (*Psamma*).



Figs. 85.

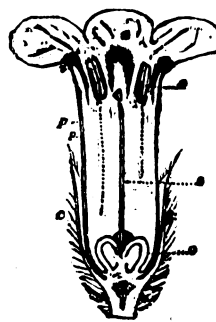


Fig. 86.

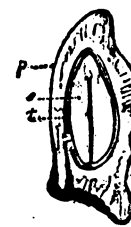


Fig. 87.

Order SOLANACEÆ, the Potato Family, is another regular-flowered corollifloral order (figs. 87 to 92). Five-membered symmetry is visible in the gamosepalous calyx, the gamopetalous corolla, and the stamens, the anthers of which often open by pores (figs. 88 and 89). The ovary consists of 2 carpels and the fruit is a 2-celled capsular berry with numerous seeds (figs. 90, 91). The embryo is often curved (fig. 93.) The character of

Figs. 85-87.—Organs of fructification of *Anchusa italica* (a kind of alkanet), to illustrate the natural order Boraginaceæ.

Fig. 85.—Diagram of the flower, with five imbricated divisions of the calyx, five imbricated segments of the corolla, five stamens, and a 4-lobed ovary.

Fig. 86.—Vertical section of the flower. *c*, Hairy calyx. *p p*, Corolla. *e*, Stamens inserted into the corolla. *a a*, Staminal appendages or corolline scales. *o*, 4-lobed ovary, two of its divisions cut through vertically. *s*, Basilar style.

Fig. 87.—One of the carpels (mericarps) cut vertically. *p*, Pericarp separable from the seed. *t*, Spermoderm, or integuments of the seed. *e*, Embryo, with plano-convex cotyledons.

the fruit distinguishes this family from the *Boraginaceæ*. There are two sub-orders; the first including the potato, the tomato, and the capsicum; the second comprehending such poisonous narcotic plants as belladonna, henbane,

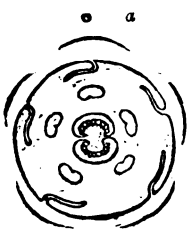


Fig. 88.

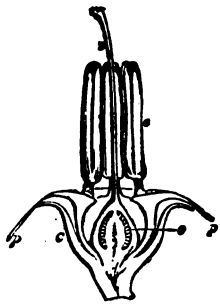


Fig. 89.

Fig. 90.

Fig. 91.

stramonium, and tobacco. In the former, which are placed in the sub-order Solaneæ, the æstivation of the corolla is valvate or induplicate (fig. 88). In the latter, which are placed in the sub-order Atropeæ, the æstivation of the corolline lobes is imbricate. In fig. 94 there is a diagram showing the row of petals overlapping each other (imbricate).

The capsular fruit of the henbane (one of the Atropeæ)

Figs. 88-93.—Organs of fructification of *Solanum tuberosum* (the Potato), to illustrate the natural order Solanaceæ, sub-order Solaneæ.

Fig. 88.—Diagram of the flower, with five divisions of the calyx, five plaited segments of the corolla, five stamens, and a two-celled ovary with numerous ovules. *a*, Axis.

Fig. 89.—Vertical section of the flower. *c*, Calyx. *p p*, Lower part of the corolla. *e*, Stamens, with porous dehiscence of the anthers. *o*, Ovary. *s*, Style and stigma.

Fig. 90.—Fruit, a kind of berry.

Fig. 91.—Horizontal section of the two-celled fruit, showing the seeds and placenta.

opens by a lid. The fruit of belladonna is a brownish-black shining two-celled berry.

2. *Group of Corollifloral Plants with Irregular Flowers.*

We shall find that they also are distinguished from each other by the character of their fruit.

Order LABIATÆ, the Dead-nettle Family (figs. 95-99.) In this order the calyx and corolla are irregular; the latter being two-lipped—the upper lip formed by two petals, the lower lip by three (figs. 96, 97.) There is a want of symmetry as regards the stamens, which are usually four, didynamous (figs. 95, 96) and sometimes two. The ovary is four-lobed, and, when mature, it forms a fruit consisting of four achenes (figs. 98, 99.) The plants of the order have square stems, opposite leaves, and their flowers are in shortened cymes, called verticillasters. Their properties are fragrant and aromatic. The order is well illustrated in the white dead-nettle (*Lamium album*), which is common on hedgebanks. To this order

Fig. 92.

Fig. 93.

Fig. 94.

Fig. 92.—The seed.

Fig. 93.—Vertical section of the seed. *t*, Integument (spermoderm) of the seed. *p*, Fleshy albumen. *e*, Embryo, which is curved.

Fig. 94.—Diagram of the flower of *Nicotiana Tabacum* (Tobacco), showing five divisions of the calyx, five imbricate corolline lobes, five stamens alternating with these lobes, and a two-celled (dimerous) ovary.

belong mint, lavender, rosemary, hyssop, thyme, sage, and marjoram.

Fig. 97. Fig. 96.

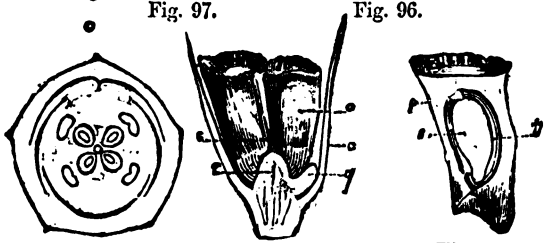


Fig. 95. Fig. 98. Fig. 99.

Figs. 95-99.—Organs of fructification of *Lamium album*, white dead-nettle, to illustrate the natural order Labiatæ.

Fig. 95.—Diagram of the flower, with pentamerous calyx; pentamerous corolla, having two lips, the upper lip being formed of two united petals, the lower of three; four stamens, in consequence of one being undeveloped, and four divisions of the ovary.

Fig. 96.—Entire flower viewed laterally. *c*, Five-cleft calyx. *t*, Tube of the corolla. *ls*, Upper lip formed of two petals. *li*, Lower lip formed of three. *s*, Style.

Fig. 97.—The flower cut vertically. *c*, Calyx. *p*, Corolla. *e*, Didynamous stamens. *s*, Style and bifid stigma. *o*, Ovary.

Fig. 98.—Fruit cut vertically, showing the achenes, two of which have been removed. *c*, Persistent calyx. *g*, Fleshy disk or gland. *r*, Receptacle, bearing the style, *s*, which is basilar, *i.e.*, arises from the lower part of the achenes. *o*, Two achenes.

Fig. 99.—Achene cut vertically. *p*, Pericarp. *t*, Integument of the seed. *e*, Embryo.

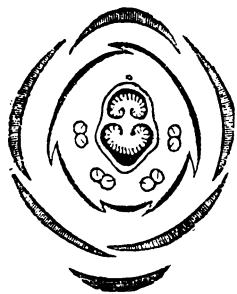


Fig. 100.

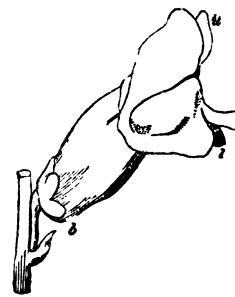


Fig. 101.

Fig. 102.

Fig. 103.

Fig. 104.

Figs. 100-104 illustrate the natural order Scrophulariaceæ.

Fig. 100.—Diagram of the flower of *Antirrhinum majus*, frogsmouth, showing a single bract below, five divisions of the irregular calyx, five segments of the irregular personate corolla, four perfect stamens, and a rudiment of a fifth above the ovary, a two-celled ovary composed of two carpels placed posteriorly and anteriorly as regards the axis.

Fig. 101.—Irregular personate flower of *Antirrhinum majus*, frogsmouth.

Fig. 102.—Vertical section of flower of frogsmouth, showing four didynamous stamens attached to the corolla.

Fig. 103.—Irregular-lipped flower of Scrophularia, figwort, with a transverse staminodium or abortive fifth stamen.

Fig. 104.—Two carpels, forming the fruit of Scrophularia, figwort. The carpels are placed anteriorly and posteriorly as regards the axis, *i.e.*, one above and the other below.

Another irregular-flowered family of plants is the Order SCROPHULARIACEÆ, the Figwort Family (figs. 100-104). In this family there is an irregular calyx and corolla, usually divided into five parts (sometimes four). The corolla is lipped or it is personate (figs. 103, 101). Stamens are 4, didynamous (fig. 102), or 2. The fruit is a 2-celled capsule formed by two carpels united (fig. 104). The order differs from the Labiatæ in having a capsular fruit in place of achenes, and in having no aromatic qualities. It may be illustrated by the common knotted figwort (*Scrophularia nodosa*), (fig. 103), foxglove (*Digitalis purpurea*), calceolaria, frogsmouth (figs. 101, 102). snapdragon, and veronica.

QUESTIONS.

1. Define the sub-class Corollifloræ.
2. Give the essential characters of Ericaceæ.
3. What is the usual form of the corolla in the heath?
4. Mention two peculiarities in the stamen of the heath.
5. In what part of the world are heaths most abundant?
6. How many kinds of heath are found in Great Britain?
7. How does the blaeberry differ from the heath?
8. How does Epacris differ from Erica?
9. In what part of the world are the species of Epacris found?
10. Give the characters of the Boraginaceæ.
11. What kind of fruit is found in the plants belonging to that order?
12. What is the nature of their inflorescence?
13. Give the characters of Solanaceæ.
14. Distinguish the sub-order Solaneæ from the sub-order Atropeæ.
15. What kinds of fruit are found in Solanaceæ? Give examples.
16. Give the essential characters of Labiatæ.
17. What kind of stamens are found in Labiatæ?
18. What kind of fruit occurs in that order?
19. What kind of inflorescence do Labiatæ exhibit?
20. Give the character of their stems and their leaf arrangement.
21. What are the properties of Labiate?

22. Give the essential characters of Scrophulariaceæ.
23. What is the character of their stamens?
24. What is the nature of their fruit?

The fourth sub-class of Dicotyledons will now be shortly considered.

Sub-Class IV.—Monochlamydeæ.

No Corolla; a calyx only, or what is called a single perianth, being present; flowers sometimes Achlamydeous, that is, having neither calyx nor corolla.

Section 1. Angiospermæ.—Monochlamydeous or Achlamydeous plants, having their seeds contained in an ovary, and fertilised by the action of the pollen on a stigma. Under this division are included such plants as the docks, the nettles, the laurels, the spurge-worts, and and the catkin-bearing trees.

Order Polygonaceæ, the Knot-grass Family, includes buckwheat, docks, and rhubarb. All the plants have a calyx and no corolla, a more or less triangular fruit (achene), containing a single erect seed (figs. 105-107). Buckwheat *(Fagopyrun esculentum)* is extensively cultivated as a kind of grain in many northern countries. The seed contains a large quantity of mealy albumen, with the embryo lying in a curved form at one side (fig. 107.)

Order Urticaceæ, the Nettle Family, is another Monochlamydeous group (figs. 108-111).—The stamens are in one flower (fig. 108) and the pistil in another flower (fig. 109). There are usually four divisions of the calyx, and the stamens have frequently elastic filaments (fig. 108). The fruit is an achene (fig. 110), and contains an erect seed with an inverted embryo (fig. 111). Some of the plants have stinging hairs. One of our native nettles *(Urtica urens)* is monœcious, while another *(Urtica dioica)* is diœcious.

Order Amentiferæ, the Catkin-bearing Family, belongs to the Monochlamydeous sub-class. It includes the wil-

low, poplar, oak, hazel, chestnut, birch, beech, etc. They have staminate flowers arranged in catkins, each flower being covered by a scale. They differ in the character of the fruit. The willows and poplars have a 1-celled fruit opening by 2 valves, and containing many hairy seeds, covered by a scale or bract. The hazel, oak, chestnut, and beech, have a dry 1-seeded fruit or nut covered by scales.

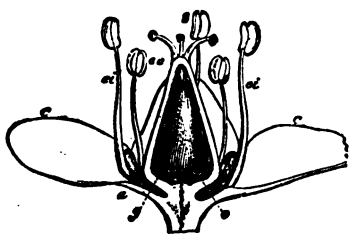


Fig. 105.

Fig. 106.

Fig. 107.

Other monochlamydeous dicotyledons have their seeds naked, that is, not contained in a seed-vessel, and are included under

Section 2. GYMNOSPERMÆ.—Monochlamydeous or Ach-

Figs. 105-107.—Organs of fructification of *Fagopyrum esculentum*, buckwheat, to illustrate the natural order Polygonaceæ.

Fig. 105.—Vertical section of the flower. *c c*, Perianth (calyx). *e e*, Outer stamens, which are introrse. *ei*, Inner stamens, which are extrorse. *a*, Glandular appendages. *o*, Ovary, with its erect ovule, *g*. *s*, Styles and stigmas.

Fig. 106.—Diagram of the flower, showing five divisions of the imbricate perianth; stamens opposite the divisions, with glands and triangular unilocular ovary.

Fig. 107.—Seed cut vertically, showing the embryo, with its superior radicle curved, at one side of the mealy albumen.

lamydeous trees, with an Exogenous structure as regards their stems and organs of vegetation, but differing from other Exogens in having naked ovules, which are fertilised by the direct application of the pollen to the foramen, without the intervention of stigma, style, and ovary.

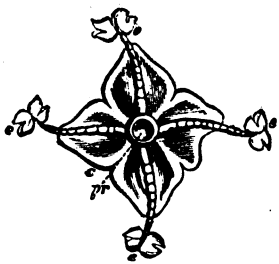


Fig. 108.

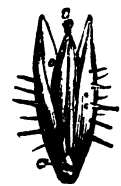


Fig. 109.

Fig. 110.

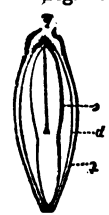


Fig. 111.

Figs. 108-111.—Organs of fructification of *Urtica urens* (small nettle), to illustrate the natural order Urticaceæ.

Fig. 108.—Staminate flower expanded. *c*, Perianth with four divisions. *e e e e*, Four hypogynous stamens, thrown back by the elasticity of the filaments, with the anthers burst. *pr*, Abortive rudiment of the central pistil.

Fig. 109.—Pistillate flower. *c*, Perianth with four unequal segments, the two exterior ones being very small. *o*, Unilocular ovary. *s*, Sessile stigma.

Fig. 110.—Pistil cut vertically, to show the direction of the erect ovule, *o*. *p*, Parietes of the ovary. *s*, Stigma.

Fig. 111.—Seed cut vertically. *t*, Integument. *h*, Hilum or base. *p*, Albumen. *e*, Embryo.

Order CONIFERÆ, Cone-bearing Family.—In this order are included such plants as fir, spruce, and cedar. They have flowers with stamens only, and others with pistils only. Their seeds, although naked, are covered by hard scales, and collected in cones, and are sometimes winged. In the genus *Pinus*, including the Scotch fir, the stone-pine, the Austrian pine, the Weymouth pine, etc., the leaves come off in twos, threes, fours, fives, and sixes. In the Norway spruce (*Abies*) the leaves come off singly from the branches. In the larch (*Larix*) the leaves appear in large clusters, and fall off in autumn; in the cedar (*Cedrus*) they are also in clusters, but they are permanent (evergreen). The woody tissue of Conifers is marked by the presence of discs.

QUESTIONS.

1. Define the sub-class Monochlamydeæ.
2. What is meant by Achlamydeous plants?
3. What plants are included in the Polygonaceæ?
4. What are the usual characters of their fruit and seed?
5. What is the usual position of the embryo in their seed?
6. Give some of the characters of Urticaceæ.
7. Mention some plants belonging to the order.
8. What kind of stamens are found in the nettle?
9. What kind of fruit has the nettle?
10. Give the characters of Amentiferæ. Give an example.
11. What kind of fruit and seed is seen in the willow?
12. Describe the fruit of the hazel.
13. Mention a peculiarity in the seed of the poplar.
14. What is meant by Gymnospermous plants? Give an example.
15. What is the nature of the fruit in Coniferæ?
16. What kind of seeds occur in the common firs?
17. What is the leaf-arrangement in the genus Pinus?
18. How are the leaves of the spruce-fir arranged?
19. How are the leaves of the larch arranged?
20. What is the difference between the larch and the cedar as regards their leaves?
21. What is the character of the wood of conifers?

We now proceed to consider the second great class of the vegetable kingdom.

CLASS II.—MONOCOTYLEDONES (ENDOGENÆ).

In this great class the plants have a *cellular* and *vascular* system, the latter consisting partly of elastic spiral vessels. The *stem* is sometimes erect and herbaceous; at other times it is creeping or subterranean, and assumes the form of a rhizome, or of a corm, or of a bulb. In palms the stem is erect and hard, usually more or less cylindrical, simple, and unbranched. The form of the stem is endogenous. There is no true separable bark, no concentric circles of wood, and no true pith. The vascular bundles are definite, and in woody stems they are most abundant towards the exterior, which becomes harder and denser than the interior. The development of the stem usually takes place by a single central and terminal bud; occasionally lateral buds are produced, and at times the stem is hollow. The *leaves* are parallel-veined. The parts of the *flower* are arranged in a ternary manner, and they are often coloured like petals, sometimes scaly. The ovules are contained in an ovary, and are fertilised by the application of the pollen to the stigma. The *embryo* has one cotyledon, and the rootlets pass through sheaths.

SUB-CLASS I.—PETALOIDEÆ.

Flowers having usually a perianth consisting of verticillate leaves, which may sometimes be separated into calyx and corolla, and are often coloured (petaloid).

a. Perianth superior. Ovary inferior. Flowers usually perfect, i.e., having both stamens and pistil.

Order ORCHIDACEÆ, the Orchis Family, is one of the most remarkable families in this sub-class of Monocotyledons. The perianth consists of two rows of coloured leaves, three of which are external and three internal,

alternating. In the inner row there is usually a marked petal called the lip (labellum) (fig. 112 *l*). The stamens and pistil are gynandrous, that is, united in one column (fig. 112 *a s*), and the pollen consists of masses attached by glands, surrounded by viscid matter, which enables them to adhere to any object which touches them. The seed-vessel has 3 parietal placentas, and the seeds are beautifully reticulated (fig. 114), the embryo in the young state being seen through the transparent covering. In the Orchises of Britain the roots have fleshy tubercules attached to them. In orchideous plants of warm countries there are thickened stems called false-bulbs. Many of the latter plants are epiphytic.

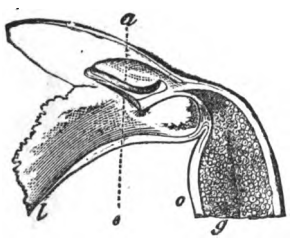


Fig. 112.

Fig. 113.

Fig. 114.

This order is easily illustrated by the common Orchises of the woods and marshes. The viscidity of the pollen-masses is observed by putting the sharpened end of a common pencil into the opening in the perianth leading down to the spur, and then withdrawing it. By doing so we find that the pollen-masses adhere to the pencil and

Figs. 112-114.—Flower of *Spiranthes autumnalis*, fragrant lady's tresses, to illustrate the natural order Orchidaceæ.

Fig. 112.—Summit of the flower cut vertically. *o*, Inferior ovary with parietal ovules, *g*. *l*, Labellum or lip. *s*, Stigma. *a*, Anther.

Fig. 113.—Anther separated. Its inner surface shown with its two cells.

Fig. 114.—A seed separated, with its external reticulated integument, *t*.

are pulled out along with it. The upper and lower parts of the seed-vessels respectively continue adherent, while the capsule opens by splitting into 6 portions. Vanille consists of the dried seed-vessels of an Orchid.

There are two other families in this section of Monocotyledons, which may be put in contrast—the Iris and Amaryllis orders.

Order IRIDACEÆ, the Iris Family (figs. 115, 116).—In this order the perianth consists of 6 coloured divisions in two rows (fig. 116), the three parts of the outer row

Fig. 115.

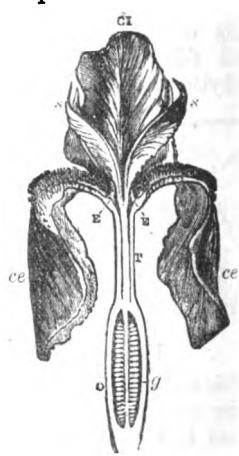


Fig. 116.

Figs. 115, 116.—Organs of fructification of *Iris germanica*, the common garden Iris, to illustrate the natural order Iridaceæ.

Fig. 115.—Diagram of the flower, showing six divisions of the perianth in two whorls, three extrorse stamens, and a 3-celled capsule with numerous ovules. *a*, Position of the axis of inflorescence.

Fig. 116.—Vertical section of the flower. *ce*, Outer divisions of the coloured perianth. *ci*, Inner divisions of the perianth. *t*, Tube of the perianth above the part which is adherent to the ovary. *o*, Inferior 3-celled ovary. *g*, Numerous ovules. *e e*, Stamens. *s s*, Petaloid portion of the style with the stigmas.

being deflexed in the Iris (fig. 116); the three stamens are placed behind three petaloid divisions of the style (fig. 116 *g g*), and the anthers open on the outside (extrorse). The fruit is inferior (below the perianth) (fig. 116 *o*), and constitutes a 3-celled capsule, opening by 3 valves, the slits being at the backs of the cells (loculicidal). The plants have rhizomes, as in the case of orris-root (the creeping stem of the Florentine Iris), or they have corms as in the crocus. Saffron, an orange dye, consists of the upper part of the style of the *Crocus sativus*.

Order AMARYLLIDACEÆ, the Amaryllis Family.—This order differs from the last chiefly in its 6 stamens, with anthers opening on the inner side (introrse). It is illustrated by the common snowdrop, the snowflake, and the narcissus. The plants have usually scaly bulbs under ground.

We now proceed to another section of petaloid Monocotyledons, where the ovary is differently placed—

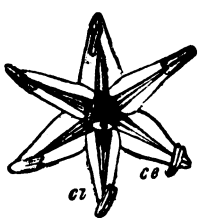


Fig. 117.

Fig. 118.

Fig. 119.

Figs. 117 to 119.—Organs of fructification of *Scilla autumnalis* (autumnal squill), to illustrate the natural order Liliaceæ.

Fig. 117.—Flowers seen from above. *ce*, Outer whorl of the perianth (calyx). *ci*, Inner whorl of the perianth (corolla).

Fig. 118.—Diagram of the flower, showing three outer and three inner leaves of the perianth, six alternating stamens in two rows, and three carpels of the ovary with the ovules.

Fig. 119.—Vertical section of the flower. *c c*, Perianth. *e*, Stamens introrse. *o*, Ovary. *s*, Style and stigmas. *g*, Ovules attached to a placenta in the axis.

2. *Perianth inferior. Ovary superior. Flowers usually perfect, i.e., having both stamens and pistil.*

Under this section we may notice the Lily, Rush, and Palm families.

Order LILIACEÆ, the Lily Family (figs. 117 to 119).—In this order there is a perianth of six divisions in two rows (fig. 117); the stamens are usually six, and have anthers opening on the inside (introrse) (figs. 118, 119). The fruit is 3-celled, and the seeds numerous. Many of the plants have bulbs, others have rhizomes, while some assume a tree-form, as *Dracæna*, the dragon-tree. The order is illustrated by lilies, leeks, onions, squill, hyacinth, fritillary, tulip, tuberose, and dog-tooth violet.

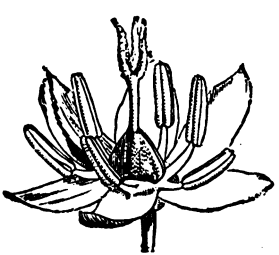


Fig. 120.

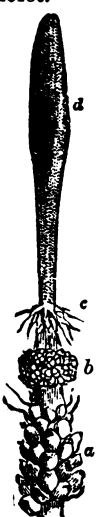


Fig. 121.

Fig. 120.—Perianth of *Luzula*, with 6 divisions of its glumaceous perianth, 6 stamens, pistil with 1 style and 3 stigmas.

Fig. 121.—Spadix of *Arum maculatum*, removed from its spathe; pistillate flowers *a*, staminate *b*, abortive *c*, fleshy end of spadix *d*.

Order JUNCACEÆ, the Rush Family, is allied to the Lily order. These plants are often confounded by common observers with sedges (carices) and bulrushes. They are at once distinguished by examining their flowers, and finding that the perianth consists of six divisions arranged in a whorled manner (fig. 120). The perianth is dry, greenish or brownish.

Order PALMÆ, the Palm Family, is also placed in this section of petaloid Monocotyledons. Their flowers resemble those of the lilies. They are small and arranged in clusters. Palms are well characterised by their stems, leaves, inflorescence, and fruit.

There is another section of petaloid Monocotyledons, in which the flowers are incomplete, that is, they have staminate and pistillate flowers. Moreover, their perianth is imperfect, being sometimes wanting, and at other

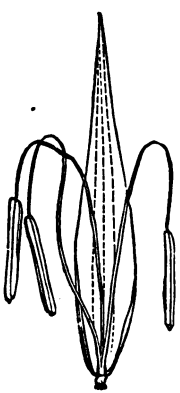


Fig. 122.

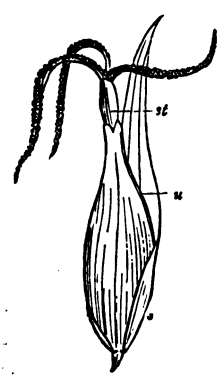


Fig. 123.

Fig. 122.—Staminate flower of *Carex*, sedge, consisting of a scale or glume bearing 3 stamens with long filaments and innate anthers.

Fig. 123.—Pistillate flower of *Carex*, consisting of a scale or glume, *s*, bearing a pistil surrounded by a special covering, *u*, through which projects the style, *st*, with its three stigmas.

times consisting of a few scales. Such plants as the cuckoo-pint (*Arum maculatum*) belong to this section (fig. 121).

We now come to the concluding sub-class of Monocotyledons—

Sub-Class II.—Glumiferæ.

Flowers glumaceous, consisting of bracts or scales, which are imbricated, and not arranged in true verticils. Leaves with parallel veins. In this sub-class there are two orders—the sedges and the grasses.

Order Cyperaceæ, the Sedge Family (figs. 122, 123). They are grassy plants with solid stems. The sheaths of the leaves are not split, as they are in grasses. The flowers

Fig. 124.

Fig. 125.

Figs. 124-129.—Organs of fructification of *Avena sativa*, common cultivated oat, to illustrate the natural order Graminæ.

Fig. 124.—Spikelet of the oat. *a*, axis of inflorescence. *ge*, Exterior or lower glume. *gi*, Inner or upper glume. *ff*, inferior fertile flower. *fa*, Two upper abortive flowers.

Fig. 125.—The same spikelet with the envelopes separated to show the internal parts. *aa*, Axis of inflorescence. *ge*, Outer glume. *gi*, Inner glume. *pe*, Outer palea of the fertile flower, with its awn (arista). *pi*, Inner palea, cleft at the apex, and apparently formed by two united. *e*, Three stamens. *o*, pistil, consisting of the ovary and two styles. *fa*, Two abortive flowers.

have either stamens and pistils, or stamens exist in one flower and pistils in another. The flowers are arranged in spikes or heads. Each flower is covered by a bract, and in the case of some pistillate flowers there is an additional covering. The stamens are usually three, and the fruit is an achene. The little embryo is at the base of albumen, and is not placed at one side as it is in grasses. The character of the flower is seen in figs. 122 and 123, the former representing a staminate flower with three stamens bearing anthers, which are fixed to the filament by their base, and not versatile as in grasses; and the latter representing a pistillate flower with its outer scales, its additional covering, with the style passing through it, and dividing into three hairy portions bearing stigmas.

Order GRAMINEÆ, the Grass Family (figs. 124-129). This is a large order of plants, and is one of the most important in the vegetable kingdom, whether we regard

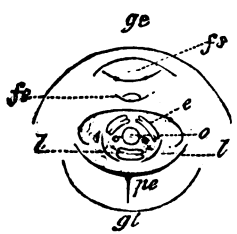


Fig. 126.

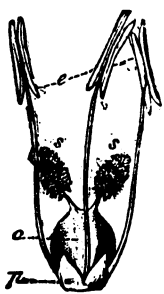


Fig. 127.

Fig. 126.—Diagram of the spikelet of the oat. *ge*, Outer glume. *gi*, Inner glume. *pe*, Outer palea with awn, the inner palea being opposite. *e*, Stamens. *o*, Pistil. *l l*, Scales or lodiculæ. *fs*, *fs*, Barren flowers.

Fig. 127.—Fertile flower deprived of glumes and paleæ. *e*, Three stamens with versatile cleft anthers. *p*, Scales (squamæ or lodiculæ) partially united. *o*, Ovary ultimately forming the grain, which consists of pericarp and seed combined. *ss*, Two styles with feathery stigmas.

it as supplying food for man or herbage for animals. The flowers occur commonly in spikelets (figs. 124, 125), which are either arranged in a sessile manner along a central axis, as in wheat, or are attached to stalks, as in oats. The spikelet consists of outer scales, called glumes (figs. 124, 125 *ge* and *gi*). These glumes (bracts) usually enclose several flowers (fig. 124 *ff* and *fa*). Each of these flowers is composed of two scales called paleæ or glumellæ (fig. 125 *pe* and *pi*). Between the outer and inner paleæ are situated three stamens (figs. 125 *e*, 127 *e*), which are hypogynous, and have anthers attached at one point to a slender thread-like filament, easily moved by the wind, and at their base scales are often placed (fig. 127 *p*). In the centre of the flower is the pistil (fig. 127 *o*), consisting of an ovary with 2 styles *s s*, which are feathery at the top. The fruit is called a grain (caryopsis), and consists of a single seed closely incorporated with the pericarp, with the embryo lying at one side (fig. 128 *e*). This embryo has a single cotyledon (fig. 129 *a*). A diagram

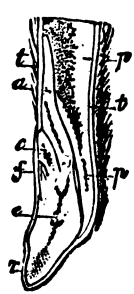


Fig. 128.

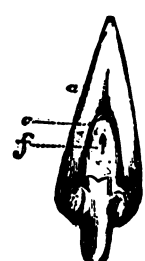


Fig. 129.

Fig. 128.—Vertical section of the caryopsis (fruit or grain), with the upper portion cut off. *t t*, Integuments of the caryopsis and of the seed united. *p p*, Perisperm. *e*, Embryo. *r*, Radicle. *a*, Cotyledon. *f*, Slit corresponding to the plumule.

Fig. 129.—Embryo separated. *r*, Radicle. *c o*, Cotyledon. *f*, Slit corresponding to the plumule.

of the part of a spikelet is given in the woodcut 126. The leaves of grasses sheath the stem, and the sheaths are split. At the upper part of the sheath there is usually seen a process called a ligule. One of the best plants for illustrating this order is the wheat. Of the common native grasses, those most easily examined by a beginner are the brome grasses, some of the larger fescue-grasses, the lyme-grass (*Elymus arenarius*), and the rye-grass (*Lolium perenne*). Among the valuable plants of the order may be mentioned the cereal grains, wheat, oats, barley, rye, rice, maize, millet, the sugar-cane, the bamboo and the tussac grass.

QUESTIONS.

1. Give the characters of the class Monocotyledones or Endogenæ.
2. Give the characters of the sub-class Petaloideæ.
3. Give the characters of the three sections of Petaloideæ.
4. Give the characters of Orchidaceæ.
5. What is meant by the labellum of orchids?
6. What is the character of the pollen of orchids?
7. How does the capsule of orchids open?
8. Give the characters of Iridaceæ.
9. What peculiarity is seen in their style?
10. How do their anthers open?
11. What forms of stems are met with in the Iris and Crocus?
12. Distinguish between Iridaceæ and Amaryllidaceæ.
13. Give the characters of Liliaceæ.
14. How do the anthers of Liliaceæ open?
15. What kind of subterranean stems occur in Liliaceæ?
16. Give the essential characters of Juncaceæ.
17. Give the characters of the sub-class Glumiferæ.
18. Give the essential characters of Cyperaceæ.
19. Describe a staminate flower of Carex.
20. Describe a pistillate flower of Carex.
21. Give the essential characters of Gramineæ.
22. What is meant by the glumes of grasses?
23. What is meant by the paleæ of grasses?
24. Describe a spikelet of a grass.
25. Describe the leaves of grasses.
26. What kind of stigmas are found in grasses?
27. What kind of anther occurs in grasses?
28. What is the nature of the fruit of grasses?

DIVISION B.—Cryptogamous or Flowerless Plants.

CLASS III.—ACOTYLEDONES.

The plants belonging to this class are in some instances composed entirely of *cellular tissue;* in other instances both cells and vessels are present. The *vascular tissue* in the higher orders consists partly of scalariform vessels. Many of them have no true stem or leaves. The *woody stem*, when present, consists of peculiar vascular bundles, which increase in an acrogenous manner. The stem of tree-ferns (which illustrate this class) is unbranched, more or less uniformly cylindrical, marked by the scars of the leaves, and sometimes becoming hollow on account of central cellular tissue disappearing. *Stomata* occur in the epidermis of the higher divisions. *Leaves*, when present, have frequently no true venation, at other times the venation is forked. There are no *flowers*, and no distinct stamens or pistils. *Reproduction* takes place by the union of cells of different kinds (antheridia and pistillidia or archegonia), by means of which germinating bodies, called *spores*, are formed. The *spore* may be considered as a cellular embryo, which has no cotyledons, and germinates from any part of its surface.

SUB-CLASS I.—ACROGENÆ.

Acotyledons, having usually distinct stems and leaves, stomata, a certain amount of vascular tissue, and thecæ or cases containing spores.

Order FILICES, the Fern Family (figs. 130-133). Stem, either a rhizome (fig. 130), which creeps along or under the surface of the ground, and emits descending roots and ascending fronds (leaves), or an acrogenous trunk which rises into the air. This trunk (caudex or stipe) is of nearly uniform diameter, hollow inside, marked on the

hard outer rind by the scars (cicatrices) of the leaves,

Fig. 130.

Fig. 131.

Fig. 132.

Fig. 133.

Fig. 130.—Rhizome of *Scolopendrium vulgare*, common hart's-tongue, with several fronds (leaves), *f'*, *f''*, *f'''*, *f''''*, in different degrees of development. In *f'*, and *f''*, the circinate vernation is seen. In *f'''*, the linear transverse sori or clusters of sporangia are seen, having the appearance of dark lines on the lower surface of the frond.

Figs. 131-133.—Frond and fructification of *Polystichum angulare*—angular-leaved shield fern—to illustrate the natural order Filices.

Fig. 131.—Part of the frond seen on the lower surface. *p*, Two pinnæ covered with sori, *s*, having an indusium. *r*, Rachis or central stalk of the frond.

Fig. 132.—One of the sori or clusters of sporangia cut vertically. *n*, The vein bearing it. *i*, Indusium or fold of the frond covering it. *c*, Thecæ or sporangia (spore-cases).

Fig. 133.—One of the thecæ separated at the period of dehiscence. *a*, Incomplete annulus, or ring, which is elastic, and causes transverse dehiscence of the thecæ. *p*, Stalk of the thecæ. *s*, Spores discharged.

and contains vascular bundles of woody, dotted, and scalariform vessels, which are arranged in an irregular manner. Sometimes the trunk divides into two (forks). The leaves (fronds) have a crozier-like (circinate) vernation (fig. 130 *f*); their veins are generally of equal thickness, either simple or dividing in a forked manner (fig. 131), or somewhat reticulated. Reproductive organs consist of spore-cases (thecæ, sporangia), which arise from the veins on the under surface of the fronds (figs. 130 *f''''*, 131 *s*, 132), or from their margin. Spore-cases are either stalked, with the pedicel passing round them in the form of an elastic ring (fig. 133), or sessile and destitute of a ring. They sometimes arise from the surface of the frond, while at other times they spring from below, having a cuticular covering in the form of an indusium or involucre (fig. 131). The clusters of thecæ are called sori (fig. 132). The margin of the frond sometimes is folded so as to cover the thecæ, and at times the frond is, as in the royal fern, partially converted into clusters of thecæ.

Ferns abound in moist insular climates. They characterise the New Zealand Flora. They are elegant frond-bearing plants, occurring largely in tropical islands and in mild climates. They sometimes occur in the form of large tree-ferns, fifty to sixty feet high, which give a peculiar feature to the landscape.

The generic characters of Ferns are founded on the position and direction of the sori, the presence or absence of an indusium as well as on the venation.

Sub-Class II.—Thallogenæ or Cellulares.

Acotyledons composed entirely of cellular tissue, having no distinct axis, no true leaves, and no stomata; propagated by means of spores, which are often enclosed in tubes called *asci*.

Under this division are included lichens, fungi (mushrooms) and algæ, or cryptogamic plants found in fresh and in sea water.

QUESTIONS.

1. Give the general characters of Cryptogamous plants.
2. What is the nature of their embryo?
3. What is the character of their stems?
4. Describe the sub-class Acrogenæ.
5. Give the characters of the order Filices.
6. What kind of sporangia occur in ferns?
7. What is meant by the indusium or involucre of ferns?
8. What kind of vernation occurs in ferns?
9. What kind of vascular tissue occurs in ferns?
10. How are the spores of ferns scattered?
11. What is meant by the sori of ferns?
12. In what climate do ferns abound?
13. Describe the sub-class Thallogenæ or Cellulares.
14. Mention some plants in this sub-class.

We have now explained the natural system of classification, illustrating it by means of several natural orders. No step can be taken in classification, or in what is called *Systematic Botany*, unless the pupil has become fully acquainted with the facts contained in the *First Book of Botany*. It is vain to attempt to understand classes, orders, genera, and species, without a thorough knowledge of the parts concerned in classification. When a student takes an unknown flowering plant into his hand, and wishes to make out its place in a system, and to know its relation and affinities, he looks first at the stem or branch, leaves, and flowers; and by the structure, venation, and symmetry of these organs, he can at once refer it to its great class in the natural system. Then, by an examination of the position of the stamens and of the perianth, by the presence or absence of the corolla, and by its character when present, he can find the sub-class and the section to which the specimen belongs. The next step is to determine the order. This requires a fuller examination of all the reproductive organs, from the calyx to the embryo. Assistance in ascertaining the order is provided by analytical tables, such as those given in my *Class Book of Botany* (pp. 791, 842, 871, etc.), or in the floras of Hooker and Arnott, Babington and Ben-

tham. The order having been ascertained, the genus is next to be determined. As British plants should be studied in the first instance, the student may have recourse to the floras just mentioned, and in these he will find the characters detailed so as to lead to the determination of the genus and species. The description, however, of plants cannot be comprehended unless the student has a sound foundation of vegetable anatomy, or, as it is called, vegetable organography.

Certain terms are used in the descriptions of plants, and without a complete understanding of these it is vain to attempt to follow the characters laid down in botanical works. Strict definitions are required in botany as in all the natural sciences, and accuracy of description is absolutely necessary. Hence the value of this science in training the mind to observe and discriminate correctly. In studying terms, however irksome it may appear, the student is not losing time. He is acquiring correct ideas as to the structure, forms, arrangements, and development of the various parts of plants, and the lesson which he thus learns will be of great service to him in after-life. Personal examination of plants in the garden and in the fields is absolutely essential to the student of botany. Thus, his studies, while they train his mental powers, also invigorate his bodily frame, and lead him to take an intelligent and comprehensive view of the plants with which God has clothed the globe, from the minute lichen or moss up to the stately trees of the forest.

II. ECONOMIC BOTANY.

In this division of the Book, we purpose to give an enumeration of some of the more important plants used in domestic economy, in manufacture, and in medicine. They will be arranged in natural orders under the Classes, Sub-classes, and Sections of the Natural System, to which we have already referred. We shall not attempt to enter into details of botanical characters, which are more fitted for an advanced book to be afterwards supplied.

CLASS DICOTYLEDONES.

SUB-CLASS THALAMIFLORÆ.

Natural order Ranunculaceæ, the Buttercup Family (see p. 29). Aconite or Monkshood (*Aconitum Napellus*). The leaves of this plant furnish the medicinal aconite, which is used to allay pain, more especially tic douloureux. It is a dangerous narcotico-acrid poison; a case is recorded of poisoning caused by the use of the root of aconite in place of horse-radish. The aconite has a short underground stem, from which dark-coloured tapering roots proceed. The crown or upper portion of the root gives rise to new plants. When put to the lips, the juice of aconite produces a feeling of numbness and tingling. The horse-radish root, which belongs to the natural order Cruciferæ, is much longer than that of the aconite, and it is not tapering; its colour is yellowish, and the top of the root has the remains of leaves on it. The aconite

grows in Europe, but it is a doubtful native of Britain. The flower is distinguished by the hood-like character of one of the blue sepals, hence the English name. A famous Indian poison, called bikh or bish, is procured from *Aconitum ferox.*

Natural order PAPAVERACEÆ, the Poppy Family. Opium is produced from the unripe seed-vessels (capsules) of *Papaver somniferum.* Incisions are made in the capsules (seed-vessels), and a milky juice exudes, which, when dried, constitutes opium. This is used to allay pain and procure sleep. The plant is a doubtful native of Britain. It is extensively cultivated in India, whence it is exported to China. Opium yields the substance (alkaloid) called morphia. The seeds of the plant are innocuous, and yield a bland oil. Import of opium into Britain in 1870, 371,665 lbs.

The petals of *Papaver Rhœas,* the red corn Poppy, are used to form a red coloured syrup, which has slightly soothing properties.

Natural order CRUCIFERÆ, the Cruciferous Family (see page 32). Cabbage, cauliflower, broccoli, savoys, Brussels sprouts, and greens, are produced by varieties of *Brassica oleracea.* Cress is furnished by *Lepidium sativum;* and water-cress by *Nasturtium officinale.* Mustard is procured from the seeds of species of Sinapis. The best mustard is yielded by *Sinapis nigra,* the black mustard plant. Mustard is also got from the seeds of the white mustard plant (*Sinapis alba*). The seeds are acrid and pungent, and when pounded and mixed with water, they are used as mustard poultices to cause redness and blistering of the skin.

Rape is furnished by *Brassica Napus;* its seeds yield oil. Turnips are the roots of *Brassica Rapa;* and Swedish turnips are got from *Brassica campestris.*

Natural order CAPPARIDACEÆ, the Caper Family. Capers used as a pickle, specially with boiled mutton, are the flower-buds of *Capparis spinosa* (fig. 134) and other species of Capparis found in the southern part of Europe,

as well as in Barbary and Egypt. The caper plant is supposed to be the hyssop on the wall mentioned in Scripture. Import of capers into Britain in 1870, 207,467 lbs.

Fig. 134.—Caper Plant (*Capparis spinosa*).

Natural order MALVACEÆ, the Mallow Family. Cotton consists of the hairs attached to the seeds of several species of Gossypium, more especially *Gossypium herbaceum*, *G. barbadense*, *G. arboreum*, and *G. peruvianum*. Cotton plants are cultivated in the United States of America (New Orleans and Alabama), East and West Indies, Brazil, and Egypt. The import of raw cotton into Britain in 1870 amounted to 11,949,157 cwts. Fig. 135.

Fig. 134.—*a*, Flowering branch showing flowers and flower-buds. *b*, Fruit.

Natural order BYTTNERIACEÆ, the Chocolate and Cocoa Family. Chocolate and cocoa are prepared from the seeds of a large tree, *Theobroma Cacao*, which abounds in the forests of Demerara. The seeds are called cacao beans. These, when roasted and reduced to powder, constitute cocoa; and the powder when mixed with sugar, vanilla, cinnamon, and arnotto forms chocolate. The bean contains a tonic substance analogous to that found in tea and coffee. Import of cocoa into Britain in 1870, 14,793,950 lbs.

Fig. 135.—Cotton Plant (*Gossypium herbaceum*).

Natural order TILIACEÆ, the Lime-tree Family. Bast or bass is procured from the inner fibrous bark of *Tilia europœa*, the lime-tree, a native of Europe. It is used in the manufacture of Russian mats, and gardeners

employ it for tying up plants. Jute or jute-hemp is a fibrous matter procured from the woody part of the stem of *Corchorus capsularis*, a native of Asia. The jute plant is much cultivated in India. The fibre is procured by maceration. It is used for manufacture in Britain. Import into Britain in 1870, 2,376,690 cwts.

Natural order TERNSTRŒMIACEÆ, the Tea and Camellia Family. *Thea* is the genus which includes the various species and varieties of tea. There are two varieties of *Thea chinenois*, both of which furnish black and green tea, *Thea Bohea* and *Thea viridis*. The latter is the chief source of the tea sent from China to Britain. The difference in the appearance and quality of teas depends partly on the species and climate, but chiefly on the time of gathering and the mode of manufacture. The tea plant is largely cultivated in China, and it has now been transported to India, where it is successfully cultivated in Darjeeling and other Himalayan districts. A species called *Thea assamica*, is grown at Assam. The leaves of the tea contain a substance called theine, which has an invigorating power. Tea imported into Britain in 1870, 141,020,767 lbs.

Natural order AURANTIACEÆ, the Orange and Lemon Family. Various species of *Citrus* yield oranges, lemons, limes, forbidden fruit, shaddock, and kumquat. They are found in tropical regions, as in the East and West Indies; they also are found in the Azores and in the Mediterranean region. *Citrus Aurantium* furnishes the sweet orange; *C. vulgaris*, the bitter or Seville orange, and the small Curaçao orange; *C. Limonum*, the lemon; *C. medica*, the citron; *C. Limetta*, the lime; *C. Decumana*, the shaddock; *C. paradisi*, the forbidden fruit; *C. olivæformis*, the kumquat of China. Import of oranges and lemons into Britain in 1870, 1,933,421 bushels.

Natural order GUTTIFERÆ or CLUSIACEÆ, the Gamboge Family. Gamboge is a yellow gum-resin, obtained by incision from the bark of a variety of *Garcinia Morella*, which grows in Siam. It is used both as a pigment and

as a medicine. Import of gamboge into Britain in 1870, 449 cwts.

Natural order CEDRELACEÆ, the Mahogany Family. Mahogany wood is procured from a large tree in central America, called *Swietenia Mahagoni*. The timber is imported from Honduras and Cuba. In 1870, 12,970 cwts. were imported into Britain.

Natural order ACERACEÆ, the Maple Family. The maples are species of the genus *Acer*, well characterised by their winged fruit, called a samara. The trees are natives of temperate regions both in the old and new world. They are ornamental and useful trees. *Acer Pseudo-platanus*, the common sycamore, is called in Scotland the plane-tree. The wood is used for furniture, musical instruments, and toys. The wood gives good charcoal. The tree thrives well even when exposed to the sea breeze. *Acer campestre*, the common maple, has often beautifully veined wood. *Acer saccharinum* is the sugar maple of North America; the stem, when tapped, yields a saccharine juice, which forms maple sugar; a tree of ordinary size will supply from 15 to 30 gallons of sap. The operation of tapping the trees takes place in February and March. In the Red River settlement another species (*Acer Negundo*) supplies sugar.

Fig. 136.—Flax Plant (*Linum usitatissimum*).

Natural order VITACEÆ or AMPELIDEÆ, the Vine Family. *Vitis vinifera*, the grape vine, is indigenous in southern Europe, and extends over the greater part of south Central Asia. It is cultivated in Europe, Asia, and North Africa, and has been carried to all quarters of the globe where the climate is suitable.

Natural order LINACEÆ, the Flax Family. The flax plant

(*Linum usitatissimum*) yields by maceration the tenacious fibres used in the manufacture of linen. It is a native of Europe and of the north of Africa. It has been long cultivated. We read of flax being grown at the time when the Israelites were in Egypt. The seeds yield an oil by expression, which is known as linseed oil. Fig. 136.

Natural order SIMARUBACEÆ, the Quassia Family. *Quassia amara*, a Surinam plant, yields a bitter wood called quassia. The quassia, however, imported for pharmacy is the produce of another tree, *Picræna excelsa*, bitter wood, and is imported from Jamaica.

QUESTIONS.

1. What plant yields aconite? from what part of the plant is it procured? and to what natural order does it belong?
2. What is the action of aconite on the human frame?
3. For what economical root has aconite been mistaken? and how can they be distinguished?
4. What plant furnishes the bikh or bish poison of India?
5. What plant yields opium? from what part of the plant is it procured? and to what natural order does it belong?
6. What is the medicinal action of opium?
7. What is the name of the red corn poppy?
8. To what natural order do poppies belong?
9. Where is the opium poppy cultivated largely?
10. To what natural order do cabbage, cauliflower, broccoli and greens belong?
11. What is the original species of cabbage?
12. What plants yield mustard? and what part is used?
13. To what natural order does the mustard plant belong?
14. What plant furnishes turnips? and to what natural order does it belong?
15. What are capers? and what plant supplies them?
16. What is cotton? whence is it procured?
17. What countries produce cotton?
18. To what natural order does the cotton plant belong?
19. What plant supplies chocolate? Which part of the plant is used?
20. What are cacao beans of commerce?
21. What is cocoa? How does it differ from chocolate?
22. What is bast? from what plant is it procured?

23. Give the natural order of the lime tree.
24. What is jute? from what plant is it obtained?
25. To what natural order does the tea plant belong?
26. Give the genus and species of black and green tea.
27. What tonic substance exists in tea?
28. To what order does the orange belong?
29. Give the generic and specific names of the orange and the lemon.
30. To what order do the kumquat and the shaddock belong?
31. What plant yields gamboge? how is it obtained? what is it used for in the arts?
32. Refer the gamboge to its natural order.
33. Refer the mahogany tree to its natural order, and mention its genus and species.
34. From what part of the world is mahogany imported?
35. To what natural order does the maple belong? Mention the genus.
36. What is the plant which yields maple sugar? and where does it grow?
37. Give the botanical name of the grape-vine, and mention its natural order.
38. What plant yields flax? Refer it to its natural order.
39. What is quassia? Whence is it procured? To what natural order does the plant belong?

CLASS DICOTYLEDONES.

SUB-CLASS CALYCIFLORÆ.

SECTION POLYPETALÆ.

Natural order LEGUMINOSÆ, the Legume-bearing Family (see page 44).—Sub-order 1. *Papilionaceæ*, Pea-blossom plants. Under this sub-order are included beans, peas, lentils, kidney-beans, and pulse of various kinds, clover, lucerne, medick, saintfoin, liquorice, indigo, kino. The greater number of the plants are nutritious or wholesome; but some are poisonous, such as laburnum seeds, the scarlet runner, Jamaica dogwood, and the Calabar bean.

Beans are the produce of *Faba vesca*, a plant which is in extensive cultivation as food for man and animals. Peas are procured from *Pisum sativum*. Clovers or trefoils, so called from their trifoliate leaves, are thus

grouped:—Red or broad-leaved clover, *Trifolium pratense;* zig-zag clover, *T. medium;* carnation clover, *T. incarnatum;* pinkish alsike clover, *T. hybridum;* white or Dutch clover, *T. repens;* yellow clover, *T. procumbens*

Fig. 137.—Common Lucerne (*Medicago sativa*).

Fig. 137.—Common Lucerne (*Medicago sativa*). *a*, branch bearing flowers and fruit; *b*, separate papilionaceous flower; *c*, stamens and pistil; *d*, pistil; *e*, the pistil beginning to roll up; *f* and *g*, mature fruit rolled up like the shell of a snail; *h*, the seed; *i*, seed cut to show the embryo.

and *T. filiforme*. These are all agrarian species, and are more or less cultivated for fodder. Lucerne is the produce of *Medicago sativa* (fig. 137).

French bean or haricot bean is the produce of *Phaseolus vulgaris*, and is extensively cultivated in France and other European countries.

The Algaroba bean or Carob tree *(Ceratonia Siliqua)* (fig. 138) has an edible pod (legume), which is used as food for horses. In Syria it is called the husk tree, and is given as food to pigs, hence the allusion in Scripture to the husks which the swine did eat. The plant is sometimes erroneously called locust tree.

Fig. 138.—Carob Tree (*Ceratonia Siliqua*).

Fig. 138.—Flowering branch, *a*, and fruit, *b*, of the Carob tree *(Ceratonia Siliqua)*.

Indigo is a dye procured from *Indigofera tinctoria* and *I. cærulea*, natives of the East Indies and other parts of Asia, and introduced into various parts of the world for cultivation. The dye is got from the plant by a process of steeping and oxidation.

Lentils are the seeds of *Ervum Lens*, common in Egypt and Western Asia, where they are used as food. They furnish red pottage, mentioned in Scripture. Import into Britain in 1870, 79,255 cwts.

Liquorice is the root of *Glycyrrhiza glabra*, which is cultivated in Spain and Italy, and also in Britain, as at Pontefract. Import into Britain in 1870, 24,942 cwts.

Sub-order 2. *Cæsalpinieæ*, the Senna division. This sub-order contains many medicinal plants and some woods used for dyeing. Logwood, *Hæmatoxylon campechianum*, is a tree of Central America which has been introduced into the West Indies. It yields timber of a brownish-red colour, which is used for dyeing. With indigo and certain mordants it is used for giving a fine black colour to silk hats, and it is also employed in certain kinds of ink. It is used medicinally as an astringent.

Senna of various kinds is supplied by the leaves of species of *Cassia*, namely, *Cassia lanceolata*, *C. elongata*, and *C. obovata*, which receive the names of Alexandrian, Bombay or Mecca, Tinnevelly, and Aleppo senna. They grow in the East Indies and in Northern Africa. Import of senna into Britain in 1870, 842,644 lbs.

Tamarind-tree, *Tamarindus indica*, found in the East and West Indies, bears pods containing seeds which are surrounded by a pulpy substance used medicinally, and as a preserve.

Sub-order 3. *Mimoseæ*, the Gum-arabic division. — Gum-arabic is an exudation from the stem of several species of acacia, among which may be mentioned *Acacia arabica*, *A. Ehrenbergii*, *A. tortilis*, and *A. vera*. They are found in eastern Africa and in Arabia. Import of

gum-arabic into Britain in 1870, 71,963 cwts. Shittim wood is the produce of *Acacia Seyal* (fig. 139).

Fig. 139.—Shittim Wood Tree (*Acacia Seyal*).

Natural order ROSACEÆ, the Rose Family (see page 47).—Sub-order *Amygdaleæ* or *Drupiferæ*, the Almond and Plum division.—Almonds are the produce of a tree called *Amygdalus communis* (fig. 140), which grows in Asia, Barbary, the south of Europe, Syria, and Asia Minor. There are two varieties of the tree, one producing sweet almonds and the other bitter almonds. The former are bland, the latter when pounded with water give out a ratafia odour from the development of prussic acid. The name of shell-almonds is given to the seed or kernel contained within the inner hard covering of the fruit. Import of sweet almonds into Britain in 1870, 36,189 cwts.; of bitter almonds, 7618 cwts.

Peaches are the succulent fruit of *Amygdalus persica*. The plant was supposed to have been originally a native of Persia, but this is not proved. It is found in China,

Cashmere, and Bokhara, and the south of Europe. A variety of peach with a smooth skin, is called the nectarine.

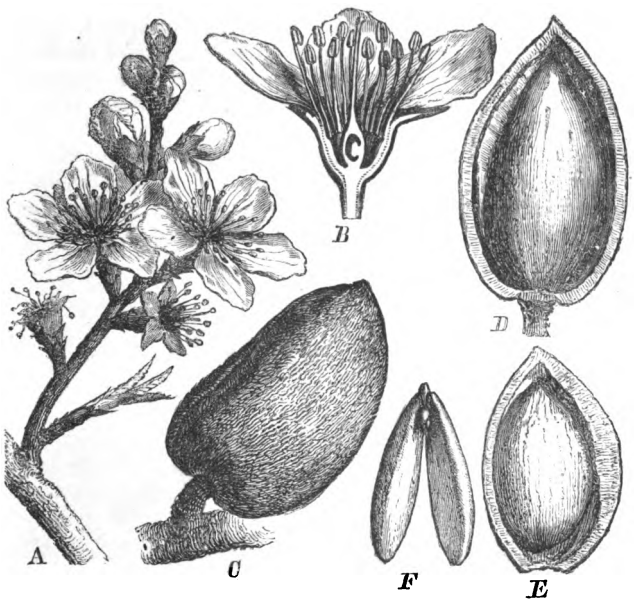


Fig. 140.—Almond Tree (*Amygdalus communis*).

The plum is the fruit of a tree called *Prunus domestica*, a native of the Caucasus and Asia Minor, and now naturalised in most of the temperate regions of Europe. Another species of prunus named *P. armeniaca*, a native

Fig. 140.—Almond tree (*Amygdalus communis*). *a*, Branch bearing flowers; *b*, one of the flowers cut vertically, with stamens attached to the calyx; *c*, fruit; *d*, the fruit cut to show the inner covering (endocarp); *e*, the endocarp cut so as to show the seed; *f*, the dicotyledonous embryo.

of southern Europe, produces apricots (fig. 142). *Prunus Cerasus*, called also *Cerasus communis*, a European plant, bears the cherry.

Sub-order *Pomeæ*, the Apple and Pear division.—In this sub-order are included *Pyrus Malus* (the apple), *Pyrus communis* (the pear), *Mespilus germanica* (the medlar), *Cydonia vulgaris* (the quince), as well as the loquat of Japan, the common hawthorn, and the rowan tree or mountain ash.

Natural order MYRTACEÆ, the Myrtle Family. Cloves are the unexpanded flower-buds of *Caryophyllus aromaticus*, which is cultivated in Amboyna and in the West Indies (fig. 141). Import into Britain in 1870, 1,089,667 lbs.

Fig. 141.—Clove Tree (*Caryophyllus aromaticus*).

Natural order CUCURBITACEÆ, the Gourd Family. Cucumbers are the fruit of *Cucumis sativus*, a native of Asia and Egypt. Gourds are the fruit of species of

Fig. 142.—Apricot (*Prunus armeniaca*). 1. Branch with fruit and leaves. 2. Branch with flowers. 3. Drupe (fruit) cut vertically, showing the seed in the interior. 4. Embryo or young plant.

Fig. 142.—Apricot (*Prunus armeniaca*).

Cucurbita. *Cucurbita maxima* is the red gourd, *Cucurbita Pepo*, the white gourd or pumpkin, and *Cucurbita ovifera*, the vegetable marrow. They are natives of hot countries within the tropics. Melons are produced by *Cucumis Melo*. This plant is cultivated extensively in Europe and Asia. The water-melon, *Cucurbita Citrullus*, is cultivated in India, China, Japan, America, and, in general, in hot, dry countries. The fruit is cool and refreshing. The medicinal substance called colocynth, is the pulpy matter of the fruit of *Citrullus Colocynthis*, which is supposed to be the wild gourd of Scripture.

Natural order UMBELLIFERÆ, the Umbelliferous or Hemlock Family (see page 50). Assafœtida, a fetid gum-resin is procured from *Narthex Assafœtida*, a native of Persia and Affghanistan. It is used to allay spasms. Caraway *(Carum Carui)*, and coriander *(Coriandrum sativum)*, yield fruits which contain aromatic volatile oils (essential oils). The plants are natives of Britain. Carrot, *Daucus Carota*, yields an esculent root. The plant is a native of Britain. *Conium maculatum* is the hemlock plant, which yields a poisonous alkaloid called conia. It paralyses the muscles of respiration, and thus causes death. It was the poison used in the case of Socrates.

QUESTIONS.

1. To what natural order and sub-order do beans and peas belong?
2. In what natural order and sub-order does clover occur?
3. Mention a poisonous leguminous plant.
4. What is the name of the common red clover of the fields?
5. What is the botanical name of the haricot bean?
6. What plant yields indigo, and in what natural order is it found?
7. What is the source of lentils?
8. Give the name of the liquorice plant. What part of the plant is used?
9. Refer logwood to its natural order and sub-order, and give its botanical name.
10. What plant furnishes senna? and what parts of the plant are used?

11. Give the natural order and sub-order of the tamarind tree?
12. Refer the gum-arabic plant to its natural order and sub-order, and give its botanical name.
13. What plant yields almonds?
14. What sort of fruit does the almond tree furnish?
15. What is meant by shell-almonds?
16. What is the difference between the sweet and the bitter almond?
17. What plant furnishes the peach?
18. What plant supplies the plum?
19. What plant supplies the apricot? Give its natural order and sub-order.
20. To what natural order and sub-order do the apple and pear belong? Give the botanical names of the species.
21. What is the source of the quince?
22. What are cloves? What is the plant which yields them? and what is the natural order to which the plant belongs?
23. What is the plant which furnishes cucumbers, and to what natural order does it belong?
24. Give the botanical names of the melon, the pumpkin, and the vegetable marrow.
25. What plant yields the drug called colocynth?
26. To what order does hemlock belong? What is the botanical name of the plant?
27. What kind of substance is assafœtida? Whence is it procured?
28. Give the names of the plant which yield respectively the carrot, the caraway, and the coriander? To what natural order do they belong?

CLASS DICOTYLEDONES.

SUB-CLASS CALYCIFLORÆ.

SECTION GAMOPETALÆ.

Natural order CINCHONACEÆ, the Peruvian Bark Family.—Catechu, an astringent extract procured from the leaves of *Uncaria Gambir*, a native of the islands of the East Indian Archipelago. It is called pale catechu. Another kind, called black catechu, is procured from the heart wood of *Areca Catechu*, and is imported from Pegu. It is called cutch, and of it 5946 tons were imported into

Britain in 1870. Import of gambir into Britain in 1870, 19,050 tons.

Coffee is the seed of *Coffea arabica*, a native of Arabia and Abyssinia, but extensively cultivated in the East and West Indies as well as in other countries. The fruit of the plant is succulent, and contains two seeds enclosed in a shell or covering formed by the inner part of the fruit, and called the parchment. The horny nourishing substance, which forms the great bulk of the seed, is the part which is roasted so as to supply the beverage coffee. It contains a strengthening principle called caffeine, which is identical with theine found in tea. Import of coffee into Britain in 1870, 179,901,864 lbs.

Ipecacuan, a well-known medicine used for coughs, dysentery, etc., is the root of *Cephaelis Ipecacuanha*, a plant which grows in Brazil, and which is now cultivated in some parts of India, more especially in Sikkim. The root is composed of a series of ring-like portions united together, and covering a fibrous portion in the centre. In 1870 the import into Britain was 62,952 lbs.

Quinine or quinia is a bitter alkaloid procured from the bark of various species of *Cinchona*, Peruvian bark trees, which grow on the Andes at elevations varying from 7000 to 8000 feet. *Cinchona Calisaya* furnishes yellow bark which contains much quinine. *C. succirubra* is the red bark, and a variety of *C. condaminea* is the pale bark. Several of the species of cinchona are now cultivated at Ootacamund on the Nilgherries, and also at Darjeeling on the Himalayas. Import of sulphate of quinia into Britain in 1870, 127,626 ounces.

Natural order GALIACEÆ, the Madder Family.—By some this is included in one order with cinchonaceæ, the order being called *Rubiaceæ*, and containing two sub-orders, *Cinchoneæ* and *Galieæ*.

Madder is the root of *Rubia tinctoria*, which is cultivated extensively in the south of Europe and in Holland. It is an important dye stuff. By a particular manipula-

tion it gives the colour called Turkey red. Another species of madder, *Rubia cordifolia*, produces the dye called munjeet in India. In 1870 the import of madder into Britain was 37,820 cwts.; of madder root, 132,749 cwts.; and of munjeet, 2749 cwts.

Natural order COMPOSITÆ, the Composite Family (see page 56).—Sub-order *Cichoraceæ*, chicory and lettuce division. Chicory or wild succory, *Cichorium Intybus*, is much cultivated in France and Germany. The roots are used as a substitute for coffee, or as an addition to it. The admixture can be detected by the microscope, which shows pieces of vascular structure when chicory is present. Import of chicory, roasted and ground, into Britain in 1870, 146,704 lbs.

Sub-order *Cynarocephalæ*, the Artichoke division.—The artichoke (*Cynara Scolymus*) is a composite plant, native of South of Europe and of Barbary (fig. 143). The part used is the receptacle on which the flowers are placed. These flowers are covered by hard scales. When the scales are removed, the flowers are seen. What is called the *choke* consists of the young unexpanded flowers. The plant called Jerusalem artichoke belongs to another division of this order, viz., Corymbiferæ. It is a kind of sun-flower, and the name Jerusalem is a corruption of girasole or sun-flower. The underground tubers are used as food.

QUESTIONS.

1. To what order does the Peruvian bark tree belong?
2. Mention some of the species of Peruvian bark?
3. Whence is catechu obtained? what are its properties?
4. What is the plant which yields coffee? what is its natural order?
5. What kind of fruit is produced by the coffee plant? and which part of the fruit is used for roasting?
6. What tonic substance is contained in coffee?
7. What is ipecacuan? mention the plant which supplies it; state its properties.
8. What is quinine or quinia? whence is it procured?

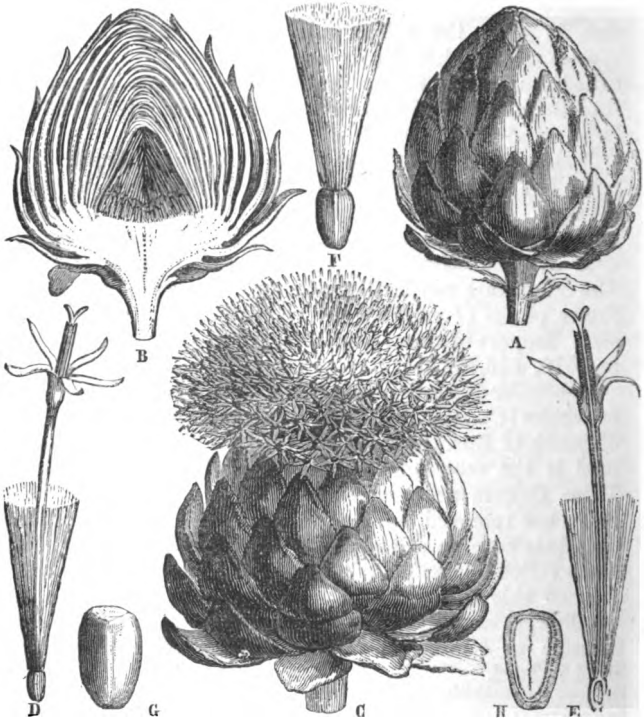


Fig. 143.—Artichoke (*Cynara Scolymus*).

Fig. 143.—Artichoke (*Cynara Scolymus*). *a*, Head of the artichoke before the flowers are expanded; it is covered by imbricated scales or bracts. *b*, Vertical section of the head of flowers in the young state, showing the bracts which form the involucre, the fleshy receptacle to which they are attached, and the flower in the state of bud. *c*, The head of flowers expanded. *d*, One of the florets showing achene below with hairy calyx attached to it, and the gamopetalous corolla with 5 divisions at the top, and the stamens with their united anthers surrounding the style, which is cleft at the top so as to form the stigma. *e*, Vertical section of a flower showing the same parts. *f*, Fruit with hairy calyx. *g*, Achene. *h*, Vertical section of fruit and seed showing embryo.

9. What plant supplies madder? mention its natural order.
10. What is madder used for?
11. What plant yields chicory? to what natural order does it belong? and what part of the plant is used?
12. What plant yields the artichoke? and to what natural order and sub-order does it belong?
13. What part of the artichoke is used for food?
14. What plant supplies the Jerusalem artichoke? and what part of the plant is used? How does it differ from the ordinary artichoke?

CLASS DICOTYLEDONES.

SUB-CLASS COROLLIFLORÆ.

Natural order EBENACEÆ, the Ebony Family. Ebony is the heartwood of several species of the genus *Diospyros*. Mauritius ebony is got from *Diospyros Ebenus; Diospyros Melanoxylon* is the ebony of Madagascar; *Diospyros hirsuta*, is the variegated Calamander wood of Ceylon and the coasts of India, which is shipped in logs and planks from Bombay and Madras. Ebony imported into Britain in 1870, 717 tons.

Natural order SAPOTACEÆ, the Sapodilla Family. Gutta-percha, imported from Singapore and Malabar, is the inspissated milky juice of *Isonandra Gutta*, the Taban tree. The juice exudes from incisions made in the stem. Other trees also yield gutta-percha.

Natural order OLEACEÆ, the Olive Family. *Olea Europæa* is the olive tree of the south of Europe and the

Fig. 144.—Olive Tree (*Olea Europæa*).

Levant (fig. 144). It has a succulent fruit which yields, on expression, olive oil. The finest oil is imported from Leghorn (called Florence oil) and Provence. The plant is cultivated for its oil, and the unripe olives are used in various parts of the world for pickles. Soaps are made from olive oil. It is one of the sources of glycerine. Import of olives into Britain in 1870, 21,846 gallons.

Natural order LOGANIACEÆ, the Strychnia Family. *Nux-vomica* is the seed of *Strychnos Nux-vomica* The seeds have a flattish rounded form, and are contained in a fruit the size of a small orange, having a brittle shell, and enclosing a pulp. They contain the alkaloid called strychnia, which is a powerful poison, and causes death by tetanic spasms, acting especially on the spinal marrow. Import into Britain in 1870, 5534 cwts.

Natural order CONVOLVULACEÆ, the Convolvulus or Bindweed Family. *Exogonium Purga* is the plant which supplies jalap. This medicinal substance is the powdered root. Its active principle is of a resinous character. The plant is a native of Mexico. Import of jalap into Britain in 1870, 169,951 lbs. Scammony is procured from the root of *Convolvulus Scammonia*, a native of Syria and Asia Minor. It is a gum resin, and is obtained by slicing the root. The resin is an active medicine. It is one of the ingredients of colocynth pills.

Natural order SOLANACEÆ, the Potato Family (see page 66). Cayenne pepper is the fruit of *Capsicum annuum*. It may be pickled or ground so as to be used as pepper. *Capsicum frutescens* and other species supply the small and very pungent fruit called chillies. Capsicums are imported from Guinea, and from the East and West Indies. *Solanum tuberosum* is the potato plant. The underground tubers, which are abortive branches, constitute potatoes. Potatoes yield a large quantity of starch.

Natural order ATROPACEÆ, the Belladonna and Henbane Family (see page 67). Belladonna, deadly nightshade or dwale, is *Atropa Belladonna*, a native plant of Britain. The leaves and roots are used

medicinally. They contain an alkaloid called atropia, which is poisonous, and causes enlargement of the

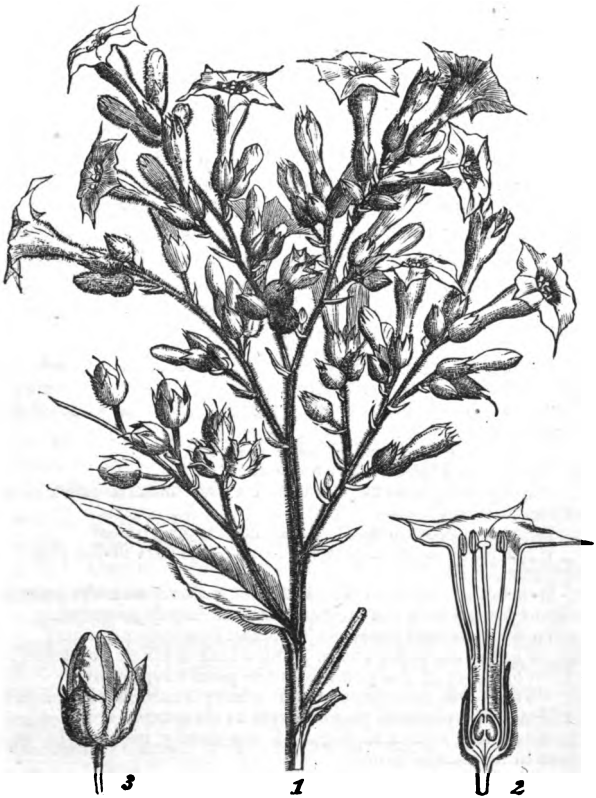


Fig. 145.—Tobacco Plant (*Nicotiana Tabacum*).

Fig. 145.—Tobacco Plant (*Nicotiana Tabacum*). 1. Branch bearing the flowers. 2. Vertical section of the flower, showing the stamens attached to the gamopetalous corolla, which is hypogynous. 3. Fruit or capsule containing the seeds.

pupil of the eye. The fruit is of a glossy black colour, and is attractive to children. It has frequently caused poisoning.

Henbane, *Hyoscyamus niger*, is also a native plant, the leaves of which are poisonous. It is used medicinally to cause sleep and to dilate the pupil. It has a seed-vessel which opens by a lid.

Nicotiana Tabacum supplies American tobacco (fig. 145). The dried leaves are used for smoking, and also for medicinal purposes The plant is poisonous, and has a powerful effect on the nervous system. It causes great sickness and prostration, faintness and palsy. Import into Britain in 1870 of unstemmed tobacco, 45,557,887 lbs.

QUESTIONS.

1. What plant yields ebony, and what part of the plant? To what natural order does it belong?
2. What plant furnishes gutta-percha, and to what natural order does it belong?
3. What is the botanical name of the olive tree?
4. Whence is Florence oil procured?
5. What plant yields strychnia? To what natural order does it belong?
6. What is nux-vomica, and what are its properties?
7. What plant supplies jalap? From what part of the plant is jalap procured?
8. Mention the name of the scammony plant, and the part of the plant from which the medicinal scammony is procured.
9. To what natural order do jalap and scammony belong?
10. What is the name of the plant which supplies potatoes?
11. What part of the plant does the potato represent?
12. What is cayenne pepper, and what plant yields it?
13. Refer the cayenne pepper plant to its natural order.
14. Give the botanical name of the deadly nightshade, and refer it to its natural order.
15. What effect has belladonna on the eye?
16. What is the name of the henbane plant? Mention a peculiarity in its seed-vessel.
17. What plant yields tobacco? To what natural order does it belong?

CLASS DICOTYLEDONES.

SUB-CLASS MONOCHLAMYDEÆ OR APETALÆ

Natural order CHENOPODIACEÆ, the Goosefoot Family. Mangold-wurzel is a root cultivated for the food of cattle. The plant is *Beta vulgaris*, var. *campestris*. It is allied to the beet-root, which is extensively cultivated in France for the purpose of furnishing sugar. Beet-root (*Beta vulgaris*) is also cultivated in England.

Natural order POLYGONACEÆ, the Rhubarb and Dock Family. Buckwheat is the produce of *Fagopyrum esculentum* (fig. 146). It is a native of Central Asia, and is now extensively cultivated in Europe. The seeds are used for making flour and bread.

Various species of *Rheum* yield the different kinds of rhubarb which are used medicinally. The best rhubarb grows in the very centre of Thibet, a region rarely visited by travellers. *Rheum palmatum* is generally said to be the plant which supplies Russian or Turkey rhubarb. Among the other species may be mentioned *Rheum undulatum*, *R. rhaponticum*, *R. compactum*, *R. Emodi*, and *R. webbianum*. The latter two supply rhubarb in India. The leaf-stalks of various species are used for tarts. Oxalic acid exists in the juice, and oxalate of lime crystals give grittiness to the roots.

Natural order LAURACEÆ, the Laurel Family. Camphor is a concrete volatile oil, obtained from the wood of *Camphora officinarum* by sublimation. The tree is found in China and Japan. In 1870, import into Britain, 14,729 cwts. Cassia-bark is the produce of *Cinnamomum Cassia*, which grows in China, Java, etc. Cinnamon is the bark of *Cinnamomum zeylanicum* (fig. 147),

Fig. 146.—Buckwheat *(Fagopyrum esculentum)*. 1. Branch, with flowers. 2. Habit of the plant; stem and root. 3. Flower, with five divisions of its calyx. 4. Ovary, with style divided into three parts. 5. Fruit (an achene). 6. Fruit cut lengthwise, showing the embryo plant.

Fig. 146.—Buckwheat (*Fagopyrum esculentum*).

a tree which is largely cultivated in Ceylon. It is used as an aromatic. In 1870, import into Britain, 2,215,434 lbs.

Fig. 147.—Cinnamon (*Cinnamomum zeylanicum*).

Natural order MYRISTICACEÆ, the Nutmeg Family. Nutmeg is produced by the tree called *Myristica moschata*

Fig. 148.—The Nutmeg Tree (*Myristica moschata*).

Fig. 148.—The Nutmeg Tree (*Myristica moschata*). 1. Flowering branch. 2. Fruit of nutmeg split open, to show the mace which covers the seed.

(fig. 148). The fruit is succulent, and splits open so as to display the covering of it, called mace, which is of a scarlet colour. The seed is contained within a shell. The seeds yield an aromatic oil. The tree grows in the Eastern Archipelago, especially on the Molucca Islands. In 1870, import into Britain of nutmegs, 537,978 lbs.; of mace, 60,869 lbs.

Natural order EUPHORBIACEÆ, the Spurge-wort Family. Caoutchouc is procured from *Siphonia elastica*, a tree of Guiana and Brazil. It yields on incision a large quantity of milky juice. The bottle india-rubber is prepared from it. Other plants also yield caoutchouc, such as species of Ficus. (See natural order *Artocarpaceæ*).

Cassava is starchy matter procured from the root of *Janipha Manihot;* when granulated, it forms tapioca. In 1870, import into Britain of tapioca, 83,845 cwts.

Fig. 149.—Castor Oil Plant (*Ricinus communis*).

Castor-oil (fig. 149) is obtained from the seeds of *Ricinus communis* by expression. The plant grows in India, and the oil is imported chiefly from Calcùtta. The plant is sometimes called *Palma Christi.* In 1870, import into Britain, 36,966 cwts.

Croton-oil is procured from the seeds of *Croton Tiglium*, a native of India and the Indian Archipelago. It is a small tree. The oil is procured by bruising the seeds, and exposing them to pressure. It is an irritant poison in large doses. It produces inflammation when applied externally to the skin. In 1870, import into Britain of croton seeds, 38 quarters.

Teak wood is furnished in Africa by *Oldfieldia africana.* It is a valuable and heavy timber. The Indian or Malabar teak is the produce of a tree called *Tectona grandis*, belonging to the natural order *Verbenaceæ.* It is not equal to African teak in durability.

Natural order PIPERACEÆ, the Pepper Family. Pepper of commerce is the fruit of *Piper nigrum.* It is a climbing East Indian plant, the dried fruit of which constitutes black pepper. When the dark outer fleshy covering is washed off we get white pepper. In 1870, import into Britain of pepper, 19,339,491 lbs.

Natural order ARTOCARPACEÆ, the Breadfruit and Mulberry Family. — Sub-order *Artocarpeæ*, Breadfruit division. In this sub-order we have the breadfruit tree, *Artocarpus incisa*, which yields an important fruit in the South Sea Islands.

Sub-order *Moreæ*, Mulberry division.—Figs are the fruit of *Ficus Carica*, the common fig, which is a compound fruit formed by numerous flowers inside a hollow receptacle. When the fig is cut open in its early state, the hollow cavity is seen lined with numerous small flowers. The tree grows abundantly in Mediterranean countries. Figs are imported largely from Smyrna. In 1870, import into Britain of dried figs was 106,504 cwts. The species of Ficus yield a milky juice. The juice of *Ficus elastica* furnishes caoutchouc. *Ficus religiosa* is the sacred

fig or peepul-tree of India; it also furnishes a kind of caoutchouc. *Ficus indica* is the banyan tree, with its numerous stem-like roots. Import into Britain of caoutchouc from various places in 1870, 152,118 cwts.

Morus nigra yields the black mulberry. This plant is supposed by some to be the sycamine tree of the Bible. The leaves of *Morus alba* (the white mulberry), and other species, are used for feeding silk-worms. Mulberries are multiple fruits formed by a considerable number of flowers united.

Natural order URTICACEÆ, the Nettle Family.—Sub-order *Urticeæ*, Nettleworts. Rheea fibre is the produce of *Böhmeria nivea*, a plant largely cultivated in India and China. The fibre is got by steeping the plant in water. It supplies the material for Chinese grass cloth. The manufactured material is used for jackets, dresses, and sail-cloth in India. Common nettle and other plants of the order yield fibres.

Sub-order *Cannabineæ*, Hempworts. Hemp is the fibrous matter procured by maceration from *Cannabis sativa*, the common hemp plant. The plant has been cultivated from the earliest times for the purpose of manufacture. It is cultivated largely in Russia. It is found in India and Persia, and is grown in many parts of the world. An Indian variety of the hemp, called *Cannabis indica*, has narcotic qualities. Bhang, Gunjah, and Haschish, are names given to the dried plant in different states. Bhang is much used for intoxication. In 1870, rough and undressed hemp imported into Britain, 983,013 cwts.

Hops are the fruit of *Humulus Lupulus*, the hop plant, which is cultivated on account of a bitter principle which exists in the resinous scales surrounding the fruit. It is a native of Europe, and is largely cultivated in the southern and midland counties of England, as in Kent, Sussex, Hampshire, Surrey, Essex, Worcester, Herefordshire, Shropshire, and Yorkshire. The plant is trained on poles from 10 to 20 feet high. The fruit is

scaly, and has a cone-like form. It is picked in autumn, and is used for flavouring beer. It is also used to promote sleep. For this purpose, a hop-pillow is sometimes employed.

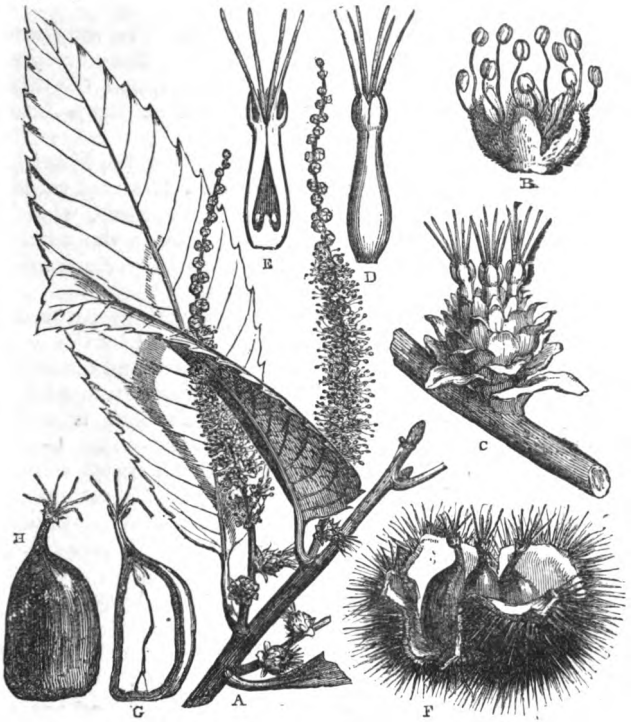


Fig. 150.—Chestnut (*Castanea vesca*). *a*, Branch bearing flowers with stamens and others with pistils. *b*, Staminate flower taken from the catkin. *c*, Pistillate (fertile) flower which ultimately produces the nut. *d*, Single pistillate flower separated. *e*, Same flower cut vertically. *f*, Outer covering of the fruit in the form of united bracts. *g*, The fruit cut vertically. *h*, One of the fruits isolated.

Natural order CORYLACEÆ or CUPULIFERÆ, the Hazel and Oak Family. The plants included in this family have barren (staminate) flowers in catkins (*amenta*), and hence they are called amentiferous.

Chestnuts are the fruit of *Castanea vesca* (fig. 150), the Spanish chestnut. It grows in Europe. The nuts are covered by what is called a burr or husk. The nuts are used much as food in the south of England, and the tree attains a great size. In 1870, import of chestnuts into Britain, 31,767 bushels.

The horse-chestnut is quite different from the Spanish chestnut. It is a seed and not a fruit. The seed-vessel of the horse-chestnut opens to scatter the seeds, which, in appearance, are like true chestnuts, hence the name. The horse-chestnut is yielded by *Æsculus Hippocastanum*, which belongs to the order Sapindaceæ.

Oak is *Quercus Robur*, a native of various parts of Europe. The fruit is the acorn, well marked by the nut covered by a sort of cup. The wood is hard and durable. The cups of the Turkey oak, *Quercus Ægilops*, are used by dyers under the name of Valonia. Oak bark is used for tanning; also, medicinally, as an astringent. Galls are produced on oaks by the attack of an insect called Diplolepis, which punctures the bark and leaves to deposit its eggs. An excrescence forms round the ova. When the insect in the gall attains a certain size, it perforates the gall and escapes. Galls, called blue galls, are not perforated, and have the insect inside. White galls have holes in them through which the insect has escaped. Galls are powerfully astringent. They are used for making ink. Galls and the bark of the oak yield tannine, which is used as a gargle for sore throat. In 1870, galls imported into Britain, 17,748 cwts.

Natural order JUGLANDACEÆ, the Walnut Family. The walnut tree (*Juglans regia*), is a graceful wide-spreading tree with fragrant leaves. It grows abundantly in the southern parts of Europe. It is also found in Asia Minor, and extends to Lebanon, Persia, and Cashmere.

The fruit has a fleshy covering, and by removing it, we display the walnut, as commonly seen in shops, consisting of a shell with a peculiar convoluted kernel (seed) inside. The outer covering of the fruit is astringent, and gives a dark dye to the fingers of those who take it off. Young walnuts are used as pickles. In them the shell is not fully formed and is soft. In 1870, import of walnuts into Britain, 152,681 bushels.

Natural order CONIFERÆ, the Cone-bearing Family. The plants of this order, consisting of firs, pines, spruces, larches, cedars, cypresses, etc., are trees supplying valuable timber, and they yield pitch, resin, and turpentine of various kinds.

Pinus sylvestris (the common Scotch fir), is a native of the northern parts of Europe, and supplies common deal as well as turpentine and pitch. Canada balsam is got from *Abies canadensis;* Strasburg turpentine is procured from the silver fir; frankincense from the Norway spruce. The cedar of Lebanon and the deodar cedar of India belong to this family. Many of the coniferous family furnish deal used for carpentry. The wood of coniferous trees can be distinguished under the microscope from other kinds of wood, by the rounded markings on the fibres. Oil of turpentine is procured from the resin of pines by distillation.

QUESTIONS.

1. What plant supplies the beet-root? Give its natural order.
2. What economical substance is procured from beet-root?
3. What is the name of the buckwheat plant? Give its natural order.
4. Where is buckwheat extensively cultivated?
5. What plant supplies rhubarb?
6. What part of the plant yields the medicinal rhubarb?
7. What salt gives grittiness to rhubarb?
8. What plant, and what part of the plant supplies camphor? To what natural order does it belong?
9. Mention the plant which supplies cinnamon. What part of the plant constitutes the cinnamon of commerce?

10. What is the botanical name of the nutmeg? What part of the plant supplies the nutmeg of commerce?
11. What is mace? What is its colour?
12. What plant yields caoutchouc? How is it procured?
13. What is cassava? Whence is it procured?
14. What is tapioca?
15. What plant, and what part of the plant yields castor oil? Give its natural order.
16. What plant, and what part of the plant yields croton oil?
17. What plant yields the African teak? Give its natural order.
18. What plant furnishes Malabar teak? To what order does it belong?
19. Mention the plants which furnish pepper. What part of the plant is used?
20. What is the difference between black and white pepper?
21. Give the botanical name of the bread-fruit tree.
22. In what part of the world is bread-fruit used for food?
23. What plant yields figs?
24. Describe a fig, and give its natural order and sub-order.
25. Give the name of the banyan tree, and of the sacred fig of India.
26. What plant yields rhœa fibre, and to what natural order does it belong?
27. What is the source of hemp? To what natural order does the hemp plant belong?
28. What is the name of the hop plant? Refer it to its natural order.
29. What are the medicinal qualities of hops?
30. In what parts of Britain is the hop cultivated?
31. What plant yields the common hazel nuts? To what natural order does it belong?
32. What plant furnishes the Spanish chestnut?
33. Describe the fruit of the chestnut.
34. What is the name of the common oak? To what natural order does it belong?
35. What economic substance is procured from species of oak?
36. What are galls? What are their properties? What are they used for?
37. Describe the fruit of the walnut tree, and mention the name of the tree.
38. What is meant by coniferous plants? Give an example.
39. What products are supplied by coniferous plants?

CLASS MONOCOTYLEDONES.

SUB-CLASS PETALOIDEÆ,

SECTION EPIGYNÆ.

Natural order ORCHIDACEÆ, the Orchid Family. Vanilla is a fragrant article of commerce, and consists of the seed-vessel of orchids, called *Vanilla planifolia* and *V. aromatica.* They are natives of tropical Asia and America. In 1870, vanilla imported into Britain, 10,785 lbs.

Natural order DIOSCOREACEÆ, the Yam Family. Species of Dioscorea, found in tropical and sub-tropical countries, yield fleshy underground tubers called yams, which are used like potatoes. They are found in Java, the Molucca and Philippine Islands, Cochin China, and various parts of Asia, as well as in the West Indies. *D. Batatas* supplies the Chinese and Japanese yams.

Fig. 151.—Ginger Plant *(Zingiber officinale).*

Natural order ZINGIBERACEÆ or SCITAMINEÆ, the Ginger Family. *Zingiber officinale* (fig. 151) has a creeping underground stem or rhizome, which supplies the

ginger of commerce, well known as an aromatic. It is imported from the East and West Indies. Import of raw ginger into Britain in 1870, 33,854 cwts.

Natural order MARANTACEÆ, the Arrow-root Family. *Maranta arundinacea*, is the arrow-root plant, which is a native of tropical America, but is extensively cultivated in the East and West Indies, and in other parts of the world. The tubers of the root yield a large quantity of starch, which is called arrow-root. It is washed out from the tubers after being reduced to pulp. It is insoluble in cold water. It consists of grains.

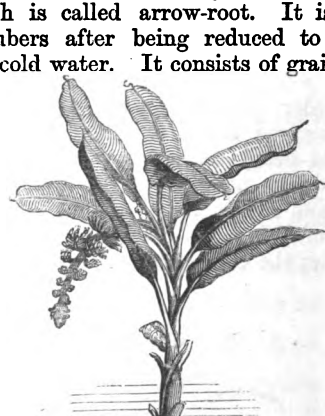


Fig. 152.—Banana (*Musa sapientum*).

Plants belonging to many natural orders of plants yield starch. Thus, in the solanaceæ, the potato (*Solanum tuberosum*) supplies starch from its tuber. So also the cassava or tapioca plant (*Janipha Manihot*) amongst Euphorbiaceæ. Portland sago, a kind of starch, is procured from the corm (underground stem) of *Arum maculatum*, whilst true sago is got from palms (*Sagus Rum-*

phii, etc.), and false sago from cycads. The structure of starch grains can be seen under the microscope. The grains of starch vary in form and in lustre. They are often marked by streaks.

Natural order MUSACEÆ, the Banana Family. The species of *Musa* are large herbaceous plants with underground stems, from which arise tall shoots bearing large leaves and clusters of fruit. *Musa paradisiaca*, the plantain, and *Musa sapientum*, the banana (fig. 152), supply well known fruits which serve for the food of the inhabitants of many tropical countries. The plants are very productive, some clusters contain from 150 to 180 bananas. *Musa Cavendishii* is a small species, which is also very prolific. *Musa Ensete* is a beautiful African species. *Musa textilis* supplies the fibre called Manilla hemp.

Natural order IRIDACEÆ, the Iris Family. *Iris florentina*, the florentine iris, has a creeping root-like stem, which furnishes orris root, a fragrant substance used for tooth powder. It has the odour of violets.

CLASS MONOCOTYLEDONES.

SUB-CLASS PETALOIDEÆ.

SECTION HYPOGYNÆ.

Natural order LILIACEÆ, the Lily Family. Aloes is the produce of various species of *Aloe*, such as *A. spicata*, *vulgaris*, *socotrina*, *indica*, and *purpurascens*. It is the inspissated juice of the plant. The species are found in the East and West Indies, and at the Cape of Good Hope. Socotrine aloes is the finest for medicinal purposes. The plant called American aloe belongs to another genus, *Agave Americana*, with an inferior ovary, belonging to the natural order *Amaryllidaceæ*. In 1870, import into Britain of aloes, 701,573 lbs.

In the lily family are found leeks, onions, garlic,

squill, and New Zealand flax. The last mentioned is the fibrous part of *Phormium tenax*. This plant yields a very tenacious fibre, which is much used for ropes and other articles of manufacture.

Natural order PALMÆ, the Palm Family. This is an order the species of which abound in warm countries. Some of them are found in temperate regions, such as the Dwarf Palm of Europe, the Palmetto, and the Hemp Palm of China. Their products are various. They supply starch, sugar, oil, wax, and edible fruits; their buds, as in the cabbage palm, are used as vegetables, their leaves form coverings for habitations and materials for manuscripts; the matting round the leaves forms coarse cloth, and the saccharine juice is fermented to form palm wine and arrack.

Cocos nucifera is the coco-nut palm, which is probably put to a greater number of uses than any other palm. The seeds yield coco-nut oil, which is solid, and used for making candles and soap. The sugar supplied by it is called jaggery. Its wood is known as porcupine wood. We must not confound *coco* with *cocoa;* the former is the palm, the latter is the substance got from the chocolate tree seeds. The coco-nut in the young state consists of three parts with several young seeds (ovules); but as it becomes ripe the parts are amalgamated, and several of the ovules are absorbed, so that when ripe the coco-nut has only one cavity containing one seed. The original three divisions, however, are indicated by the three ridges and three round depressions on the inner shell (endocarp). One of the round depressions can be easily perforated so as to form a hole, and through this hole the parts of the young plant appear when they begin to sprout. Import of coco-nuts into Britain in 1870, 3,546,276 in number.

Ceroxylon Andicola is the wax palm of the Andes (fig. 153). *Copernicia cerifera* is another wax palm of South America. *Elais guineensis* is the oil palm of Guinea, the oil of which is solid (fig. 154).

Phœnix dactylifera, the date palm, mentioned in Scripture. Import of dates into Britain in 1870, 93,873 cwts. *Phytelephas macrocarpa*, the vegetable ivory palm. The nut is very hard, and used like ivory. Import into Britain in 1870, 31,430 cwts. of the vegetable ivory nuts.

Fig. 153.—Wax Palm (*Ceroxylon Andicola*).

Fig. 154.—Oil Palm of Guinea (*Elais guineensis*).

QUESTIONS.

1. Whence is vanilla procured? What part of the plant supplies it?
2. Describe a yam, and mention the genus to which it belongs.
3. What part of the ginger plant is used? Give the name of the plant.
4. Mention the arrow-root plant, and the part from which arrow-root is obtained.
5. Mention some plants which are used for supplying starch.
6. What is the orris root plant? What part of the plant is used?

7. What plant yields the medicinal aloes?
8. What plant supplies New Zealand flax?
9. What is the name of the coco-nut palm? In what climates does it abound?
10. What is the wax-palm of the Andes?
11. What is the oil palm of Guinea? What part yields oil, and what is the nature of the oil?
12. What is the date palm?
13. What is vegetable ivory, and what palm yields it?

CLASS MONOCOTYLEDONES.

SUB-CLASS GLUMIFERÆ.

Natural order GRAMINEÆ, Grasses. In this order we find the various kinds of grain and pasture grasses.

Wheat is the fruit or grain produced by *Triticum vulgare*. The variety called spring wheat is sown in spring, and that called winter wheat is sown in autumn. The zones of wheat may be said to embrace those parts of Europe and western Asia, which lie north of the 60th degree of latitude. *Avena sativa*, the oat, is one of the northern grasses. *Hordeum distichum* (barley) is a grass of northern climates.

The zone of barley, oats, and the potato, includes the high districts of Scandinavia, Faroe Islands, Shetlands, and the most northern parts of Scotland and Ireland.

Secale cereale, rye, is cultivated in a considerable part of Europe north of the Alps.

Zea Mays, Indian corn, is a grain of warm climates (fig. 155). It is the principal cereal grain of the tropical zone. In 1870, import of maize into Britain, 16,756,783 cwts.

Oryza sativa, rice, is the grain which is said to support the majority of the human race. It is the staple grain

Fig. 155.—Maize or Indian Corn (*Zea Mays*). *a*, General habit of the plant. *b*, The pistillate spike before maturation, deprived of its bract or envelope *c*, Pistillate flower with a long pistil. *d*, Collection of fruit in the form of a spike. *e* and *f*, Fruits (grains) shown separately. *g*, Vertical section of fruit. *h*, Staminate spike. *i*, Staminate flower.

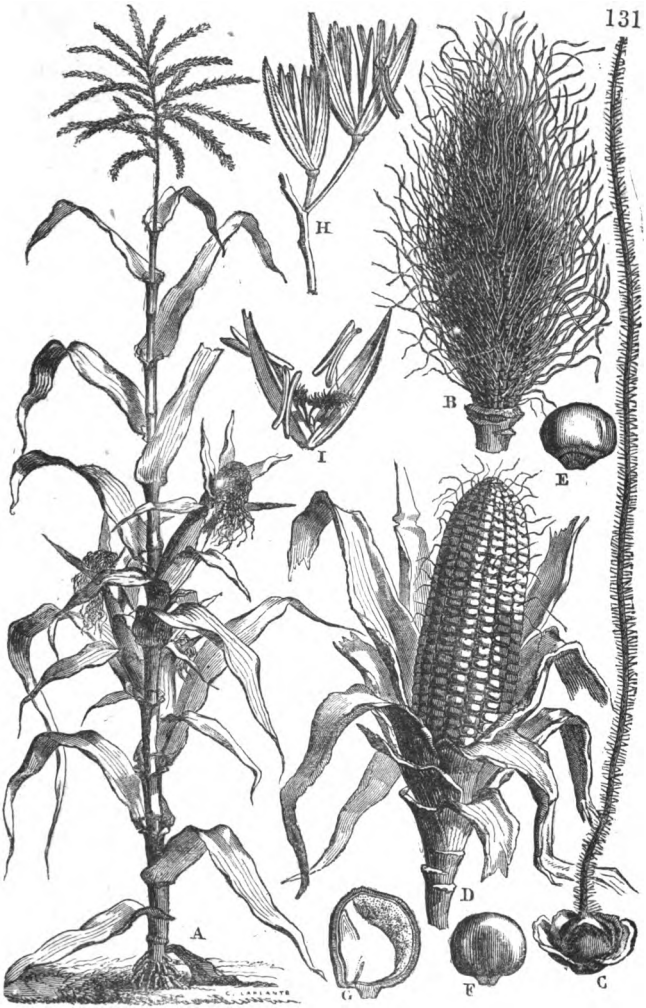


Fig. 155.—Indian Corn (*Zea Mays*).

of India and China. In 1870, import of rice into Britain, 4,077,409 cwts. The zone of rice and wheat is in those countries which are subject to the influence of tropical seasons. In tropical western Africa, rice and maize are the chief grasses.

Bambusa arundinacea, bamboo cane, is a most valuable grass in warm countries. In 1870, import of bamboo canes into Britain, 287,691.

Among pasture grasses may be enumerated the following:—*Lolium perenne* and *L. italicum*, rye grasses; *Phleum pratense*, Timothy grass; *Dactylis glomerata*, cock's-foot grass; *Cynosurus cristatus*, dog's-tail grass; *Poa annua*, *P. pratense*, and other species of meadow grass; *Festuca ovina*, sheep's fescue, and other species of fescue; various brome grasses, the bunch grass of North America (*Elymus condensatus*).

Saccharum officinarum, the sugar cane, is a valuable grass of warm countries. In 1870, import of refined sugar into Britain, 1,710,176 cwts.; of unrefined sugar, 12,798,631 cwts.

Andropogon citratum, the lemon grass, yields a fragrant essential oil.

CLASS ACOTYLEDONES.

SUB-CLASS THALLOGENÆ.

Fig. 156.—Mushroom (*Agaricus campestris*).

Natural order FUNGI, the Mushroom Family. *Agaricus campestris*, is the common mushroom, which is extensively used as food. The under surface of the cap of the mushroom is composed of pink coloured laminæ, called gills (fig. 156).

Tuber æstivum, the truffle, is an underground fungus.

It is scented out by means of dogs and pigs. Other species of Tuber also yield truffles, such as *T. cibarium*. Import of truffles into Britain in 1870, 54,931 lbs.

QUESTIONS.

1. To what natural order does wheat belong?
2. What is the name of common wheat?
3. What plant yields oats?
4. Give the generic and specific names of barley.
5. What plant yields rye?
6. Give the name of the plant which yields Indian corn. In what part of the world is it chiefly cultivated? Give another English name for it.
7. Give the name of the rice plant. What climate is suited for rice?
8. Give the name of the bamboo. To what natural order does it belong?
9. Mention some of the common cultivated pasture grasses.
10. What is the name of the sugar cane? In what climates is it cultivated?
11. Give the name of the common mushroom. To what natural order does it belong?
12. What are the gills of a mushroom, and what is their colour?
13. What plant supplies truffles?
14. What kind of fungus is the truffle?

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